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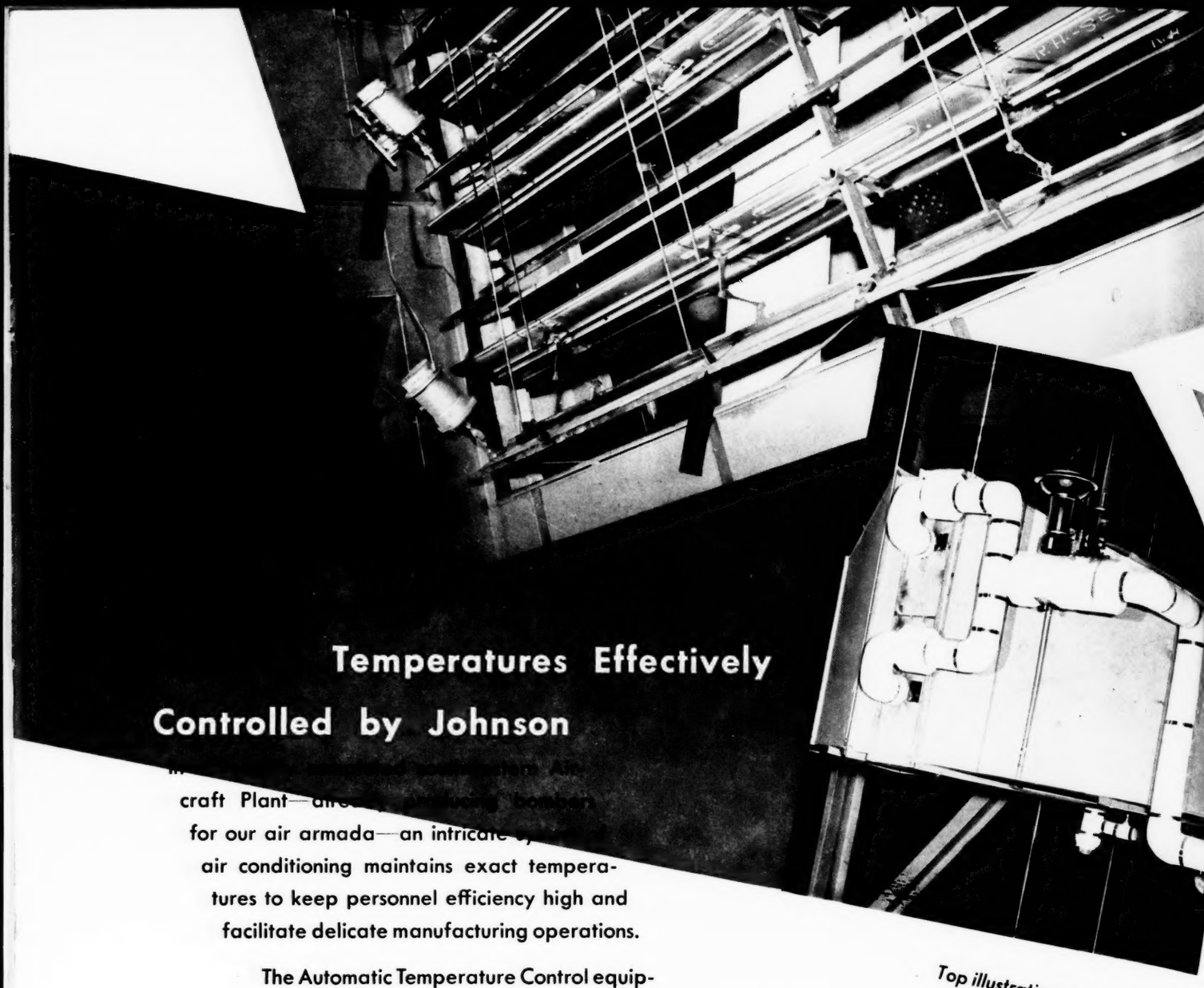
HEATING AND VENTILATING

THE AIR CONDITIONING MONTHLY

MARITIME REFRIGERATION NUMBER ★ NOVEMBER, 1943



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Top illustration: Johnson piston-type damper control actuates the Johnson return air dampers.

Lower illustration: Johnson valve on booster heater coils in ducts which carry super-heated air to outside walls, where winter heat losses are greatest.

BACK THE ATTACK—BUY MORE BONDS

JOHNSON

Automatic TEMPERATURE AND AIR CONDITIONING *Control*

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VOLUME 40, No. 11

HEATING AND VENTILATING

The Air Conditioning Monthly

FOR

Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning.

THIS MONTH'S COVER

A merchant vessel of a convoy climbs over a mountain of sea. Official U. S. Navy photograph.

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THIS ISSUE: ONE DOLLAR

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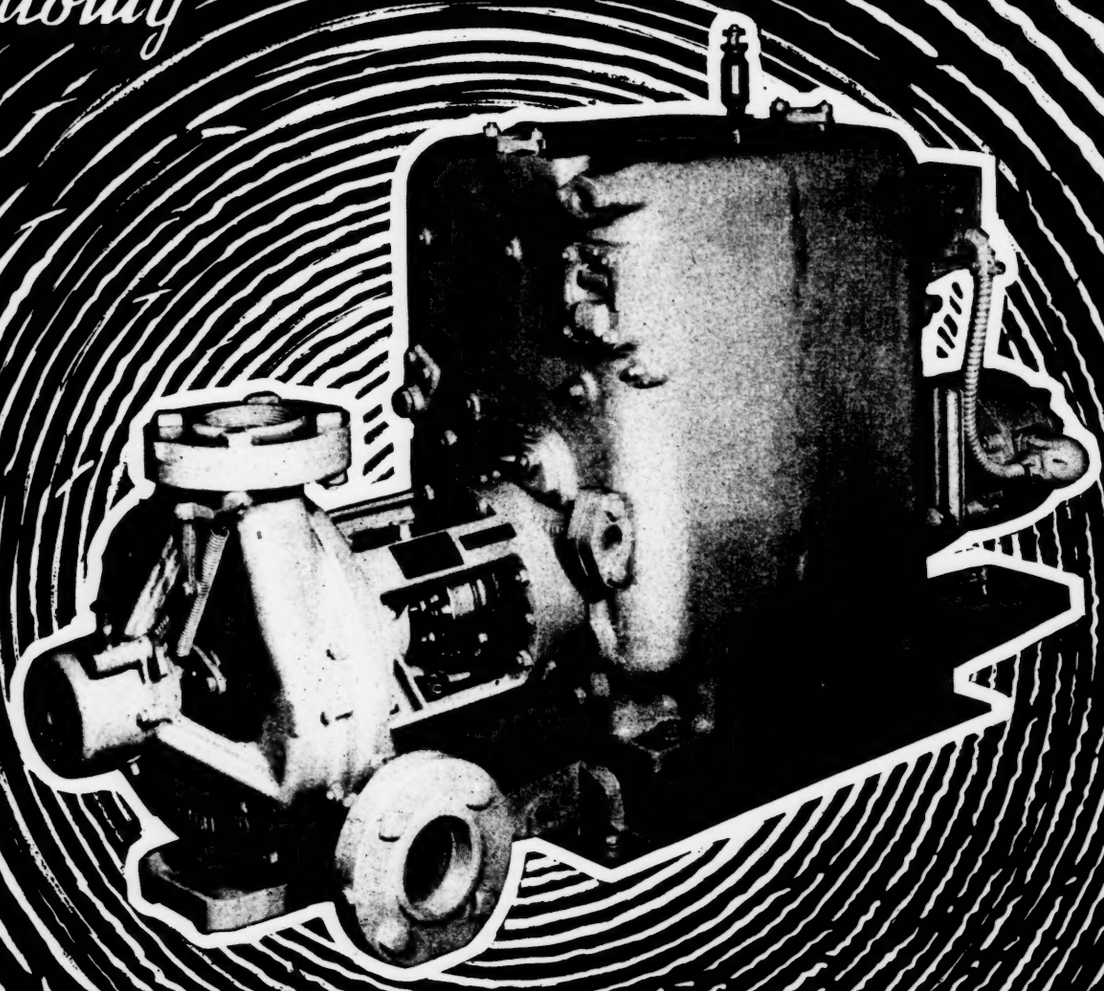
Centralized Heating Economy



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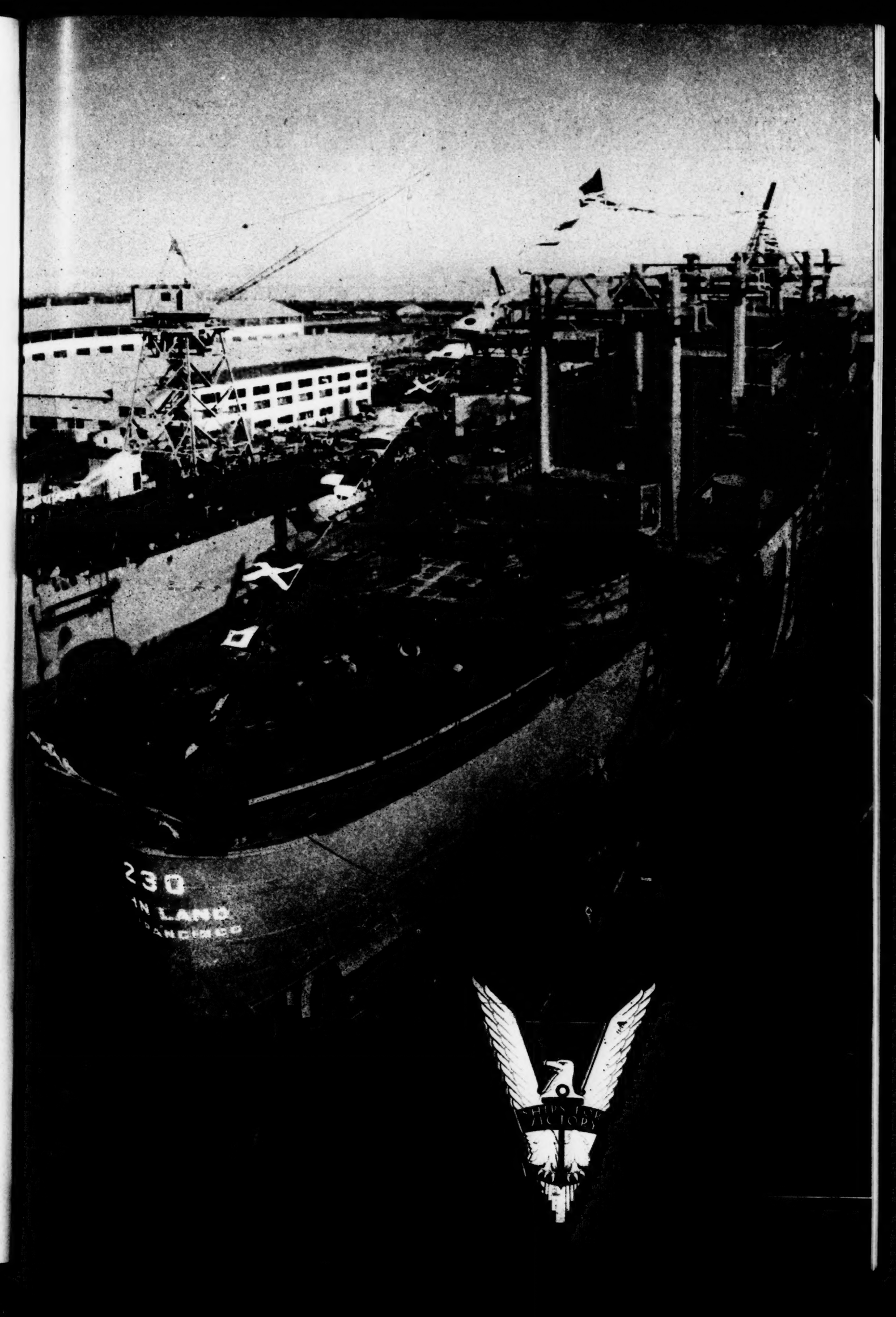
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IN LAND
SHIPS FOR
VICTORY

By REAR ADMIRAL HOWARD L. VICKERY, U. S. N.,
Vice-Chairman, U. S. Maritime Commission, and
Deputy Administrator, War Shipping Administration

DEVELOPMENTS in merchant shipbuilding since the United States was drawn into the war have made our country shipbuilder to the United Nations. The emergency building program, out of which there came the first Liberty Ships the same month Pearl Harbor was attacked, has since produced more than 1,500 of these sturdy cargo vessels. They have provided a great part of the ocean transportation so necessary to war on a global scale.

Construction methods by which these 10,800 deadweight ton vessels are built so rapidly have radically revised shipbuilding methods of long standing. They have been so effective as to reduce the national average building time from 241.3 days for the three Liberty Ships delivered in January 1942 to 41.2 days for the 106 delivered in September 1943. The national average, moreover, is far above the record of individual yards, the most efficient of which has delivered a Liberty Ship in as little as 20 days in regular production.

The Liberty Ship is the backbone of our wartime merchant fleet. Growing output of the Liberty program enabled our shipbuilders to produce in 1942 a total of 746 ships of which 542 were emergency vessels, and exceed the Presidential directive of eight million tons for the year. The emergency program continues in 1943 to produce 65 to 70% of the more than nineteen million deadweight tons scheduled for the year, a figure that is nearly 17 times the tonnage built in 1941.

Glorious as is the record of the Liberty in meeting the critical shortage of ships that confronted the United Nations, they have never been conceived as anything but emergency vessels. Lack of manufacturing facilities for more modern propulsive equipment in the early stages of the program, decreed that Liberty Ships would be propelled by triple expansion steam engines of 2,500 horsepower, giving them the relatively slow speed of about 11 knots.

This one factor alone makes Libertys easier prey for enemy raiders than the faster vessels. Too, it unsuits them for the fast competition that may be expected in the post-war era of international commerce.

In recent months, as the result of continued effort by the Maritime Commission over more than two years, there have become available facilities for manufacture of geared turbine propulsion machinery in quantity. The Commission, accordingly, has designed the Victory Ship, a faster, trimmer vessel of about the same deadweight capacity as the Liberty, which will utilize the more modern power plant rated 6,000 horsepower or more, and will develop speeds of 15 to 17 knots. Greater speed will give these vessels decreased vulnerability to attack, and their design and equipment will make them more adaptable to peacetime cargo-passenger commerce.

The Victory is designed for assembly-line methods of production as is the Liberty. The first Victory keel is scheduled for laying in late November and the first delivery in late spring of 1944.

Around the Victory Ships and the Commission's

Last February the heating and ventilating of the vessels being built under the direction of the U. S. Maritime Commission were described on these pages in a section which, judging from readers' comments, was of extraordinary interest. The corollary subject of refrigeration of these vessels is, it is believed, of just as great interest, and, consequently, this issue features Maritime Refrigeration.

The editors are privileged to present, as an introduction to this section, the accompanying article by Rear Admiral Vickery which high-lights the Commission's spectacular program; the picture he draws will make every American proud of his country's accomplishments in ship construction and refrigeration men equally proud of the part their art is playing in the shipbuilding program.

fine, modern C-types there will be built the United States' post-war merchant fleet. The C-types, with which the Commission inaugurated its long range program in 1936-37, received increased attention beginning with September of 1942, when geared turbine equipment became increasingly available. Fifty-nine of the vessels were built in 1942. But their construction was so accelerated in 1943 that by the end of June 84 C-types had been delivered and in the ensuing three months 37 more were put in service.

Tanker construction also has been given new impetus in 1943. Our tanker yards produced 62 high speed oceangoing liquid cargo vessels in 1942. But, in the first half of 1943, 65 oceangoing tankers and seven coastal tankers were built, and in the third quarter 45 of the larger tankers and 13 coastal tankers were added.

Thus is shown the results of our enormous wartime shipbuilding program. The courage and ingenuity of our shipbuilders have been amazing. Difficulties that have beset the program have at times seemed insurmountable. But, all along the way there has been remarkable cooperation between labor, management and government, and a determination to build ships, whatever the sacrifice, that has been inspiring. Demands of Selective Service have caused labor shortages in shipyards as well as in other industries. Many of the personnel increases and replacements have been taken up by women workers. About 90% of the shipyard workers had to be trained. Housing and transportation have caused difficulties.

But American perseverance is winning. Our merchant vessels continue to be delivered at the rate of five or six every day. Shipyard production is geared to a schedule that can produce twenty or more millions of deadweight tonnage every year, for as long as is required to defeat the enemies of the United Nations.

A comprehensive description of the refrigeration systems for U. S. Maritime Commission vessels with particular emphasis on Liberty Ships. The following article is devoted to details of refrigeration design and construction as applied at one yard—that of Consolidated Steel Corp.—in building C1 cargo and passenger vessels. The two articles thus cover both the broad concept for all types plus details and variations on one type of vessel.

THE purpose of this article is to give the reader some idea of the types of equipment and materials and of the general design of the refrigeration systems being installed by the U. S. Maritime Commission on its many different types of cargo ships, tankers, tugs and other auxiliaries. It is principally concerned with the installations intended for preserving the fresh foods for use by the crew during the voyage, but also considers briefly the equipment used for water cooling and other miscellaneous services, and for cargo refrigeration.

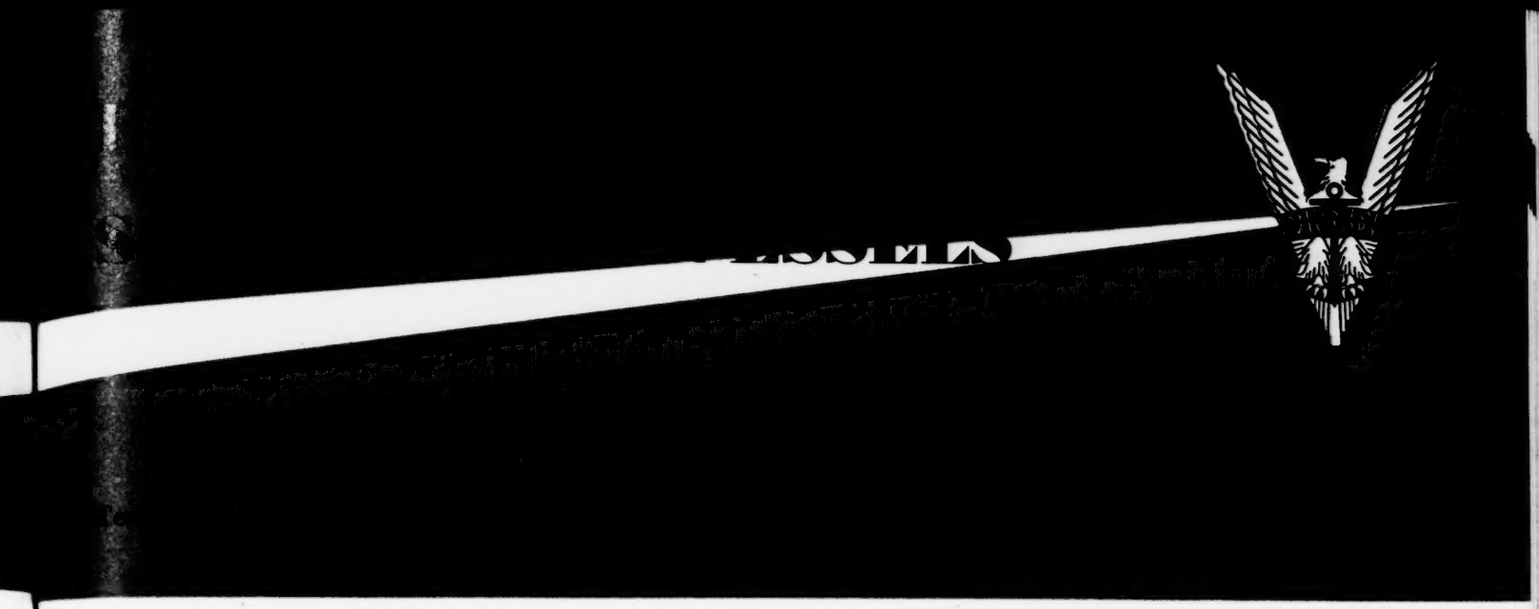
First, let us establish a general conception of a typical ship's stores refrigeration system. All of the systems are designed for the direct expansion of Freon-12 and all equipment is designed for automatic operation. Freon-12 is chosen for several reasons. The low pressure operation obtainable with Freon as opposed to ammonia or carbon dioxide is of prime importance. Lower pressures are in themselves safer and eliminate many dangers inherent in systems designed for the use of other refrigerants. Then, too, weight is a major consideration in a shipboard installation since every pound removed from the machinery means that another pound of valuable cargo can be transported. None of these factors would eliminate the use of methyl chloride. However, there are other considerations that influence the choice of Freon - 12. These are the toxic properties of the gas, and its inflammability. Since methyl chloride is toxic and inflammable and Freon is non-toxic and non-inflammable, these two final factors determine the choice of Freon-12. Incidentally, if a toxic or inflammable refrigerant should be used in a ship's system, there are other additional safety regulations imposed by the regulatory bodies mentioned below.

All electrical equipment installed on shipboard must be in accordance with the Marine Rules of the American Institute of Electrical Engineers. The electrical systems of most of the Commission's ships operate on 230 volts, D.C. Some, and the Liberty ship is one, operate on 115 volts, D.C., and there are a few groups of ships that are equipped with 440 volt, 3 phase, 60 cycle, alternating current generators, and the refrigeration motors operate at full ship's voltage. Room controls are usually arranged for operation on 115 volts because of the fact that power feeders (230 volts D C. or 440 volts A.C.) are seldom available in the ship's stores refrigeration space and consequently a lighting circuit is utilized.

There are two other codes that must be complied with in making a marine installation. These are the codes set up by the Merchant Marine Inspection Service of the United States Coast Guard and the American Bureau of Shipping. These codes impose but little hardship because they are designed to insure the safety of the crew and of the ship and require little if any more than would the average designer who is at all interested in safety and satisfactory operation.

Further, refrigerated spaces must be constructed in accordance with the rules of the United States Public Health Service. These rules are also good common sense rules and are naturally designed to insure the health of the crew.

Each of these regulatory bodies has inspectors, and, of course, the building yard and the Maritime Commission itself keep an eye on all phases of the installation so that any ship that is delivered into service is assured of the very finest refrigeration system obtainable today. Although it is not a legal code, the recommendations of the Senate Report



No. 184, which is the report of the Senate Committee on the Morrow Castle and Mohawk disasters, are adhered to by the Maritime Commission.

It is quite possible that those who are familiar only with shore installations do not appreciate the importance of a routine marine refrigeration, particularly under war time conditions. One has only to consider that today there are very few ports within the several theaters of war where a ship can obtain any fresh food to realize that the five or ten horsepower used in a ship's stores system is some of the most important power expended aboard ship. The Commission has every desire to do everything in its power to keep the officers and crew of its merchant ships well fed and healthy at all times and this desire is particularly strong today when the task of sailing the seas is anything but a safe one.

Next let us consider the general specifications laid down by the Commission. It should be kept in mind that the equipment described below is intended for use in the ship's stores systems.

Compressors and Condensers

The compressors are of the vertical, multi-cylinder, single acting, air cooled type. They are furnished complete with suction and discharge stop valves, relief valve, initial oil charge, oil sight glass, suction strainer, connections for pressurestat and suction and discharge pressure gages; V-belts, motor pulley, flywheel, belt guard and structural steel base. This base is designed to accommodate the driving motor and to provide for necessary belt tension adjustment by means of universally adjustable motor rails.

Compressors are designed so that suction returns enter the cylinders direct. Pistons are of the double trunk type with suction valves in the piston. Lubrication may be of either the splash or forced feed type depending upon the size of the compressor. Compressor speed is limited to 750 rpm and the corresponding piston speed must not exceed 550 fpm. Experience has shown that, while considerably higher speeds are satisfactory for land work, the effects of rolling and pitching and even permanent list or trim introduce trouble when high speed operation is employed. All equipment must be designed for a 30° instantaneous or 15° permanent list as well as for a 5° trim, fore and aft.

Condensers are usually of the horizontal straight shell-and-tube type. Exceptions are those air cooled condensers used on some tugs and small ships. The materials used in the water cooled condensers have undergone quite a change as a result of material conservation measures undertaken by the Maritime Commission in recent months. Before the war, when copper and nickel were plentiful, the materials were as follows:

Shell—Rolled Copper or Brass
Tubes—Cupro-Nickel
Tube Sheets—Cupro-Nickel
Tube Supports—Brass

As a result of the conservation measures, materials currently being used are:

Shell—Steel
Tubes—Aluminum Brass
Tube Sheets—Muntz Metal or Naval Brass
Tube Supports—Steel or Commercial (yellow) Brass

Water heads have regularly been of heavy cast iron, but recently a coating of bitumastic has been applied to the inside of the heads to help inhibit erosion. Tubes are ⅝ in. O.D., No. 18 BWG and are usually arranged in four or six passes. They are roller expanded to the full depth of the tube sheets in drilled, reamed and grooved holes and are then finished off flush. Some manufacturers also silver solder the tubes into the sheets for additional security. Shell connections are extra heavy IPS half couplings welded to the shell and include one inlet, one purge connection and two outlets. One of these outlets is placed at each end of the shell so that a permanent list or unusual trim of the ship will not cause a partially flooded condition. Thread protectors are provided for shipment.

The effective cooling surface must be designed for use with 88F sea water. This is higher than is usual in shore practice but is necessary because of the high temperatures encountered in some tropical har-

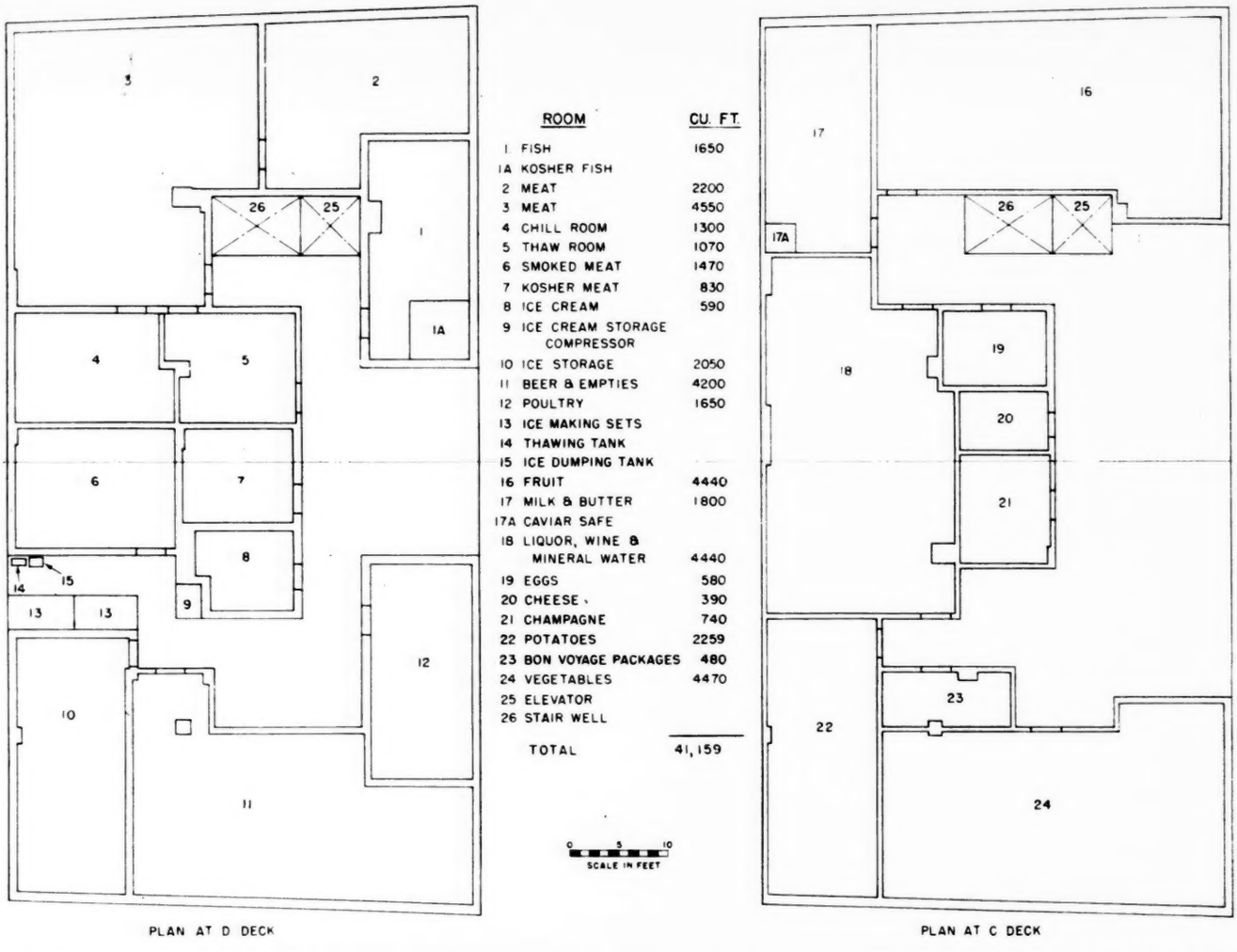


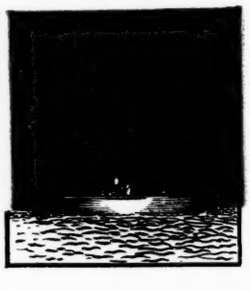
Fig. 1. Arrangement of ship's stores rooms on a large passenger ship. Irregularities in walls are caused by stanchions and pipes leading from decks above.

bors and even in such extensive bodies of water as the Red Sea. It is also required that the condensers be designed to use not more than five gallons of cooling water per ton of refrigeration and there must be sufficient tubes in each pass to limit the water velocity to an amount not to exceed five feet per second.

Condenser Tests

The Commission requires that the tubes and water heads be tested hydrostatically to 200 lb per sq in and that the shell be tested with air under water to 300 lb per sq in.

The final test used by the Commission is to charge the condenser shell with a mixture of dry air and Freon-12 gas and to seal all connections. Then, after four hours, one of the water head connection seals is removed and a halide torch is used to test for the presence of Freon on the water side.



Receivers and Instruments

Receivers are generally constructed of black steel pipe and arranged for vertical mounting. The heads are made from standard welding pipe caps fastened to the shell so as to be concave to the pressure. Connections consist of one inlet, one outlet, and one drain connection. Two bull's-eye sight glasses are provided. Shell connections are of a type similar to those described above for the condensers.

Receivers must be arranged so as to insure a liquid seal on the refrigerant outlet. They must be large enough to hold the refrigerant charge for the largest room connected to the system.

Dehydrators are permanently installed in the liquid line from each receiver. They are of the side outlet type so that the cartridges may be removed without disturbing the piping connections. The piping is arranged so that the dehydrators may be cut out of the system for

normal operation or inserted in the system for periodic drying of the refrigerant. The drying agent used is activated alumina.

A suction and a discharge pressure gage are installed for each compressor. The suction gage has a range of from 30 in. vacuum to 100 lb per sq in; the discharge gage has a range of from 0 to 300 lb per sq in. They are of 3½ or 4½ in. in diameter with steel, brass or phenol cases. When the gages are installed directly on the compressors rather than on a conveniently located gage board, phenol cases are not recommended. The movement is phosphor bronze bushed and the dials, in addition to the pressure graduations, carry a scale indicating the corresponding saturated Freon-12 temperatures.

Thermometers are provided to indicate the temperature of the circulating water as it enters and leaves the condensers. If there is more than one condenser, one thermometer is installed in the common supply line and one at each condenser water outlet. These thermometers are of the glass front, industrial type and have separable brass sockets.

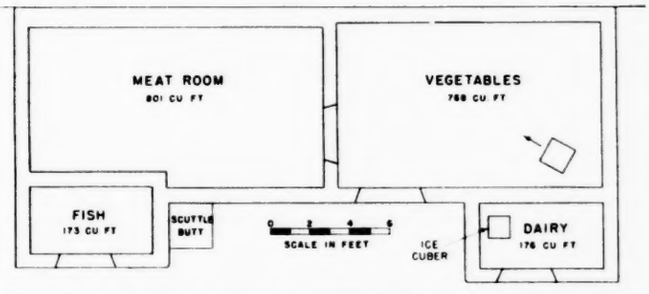


Fig. 3. An air cooler is provided for the vegetable room of Liberty Ship; the other three rooms have pipe coils.

Thermometers used for indicating room temperatures are of the mercury actuated, remote reading, dial type. They have phenol cases and 4½ in. dials with a range of from 0 to 120F. The thermometers are mounted outside of the refrigerated spaces in a location readily accessible for inspection by the crew.

Controls

Controls employed are similar to those used on any good refrigeration system. Each room is provided with a thermostat, solenoid valve, thermal expansion valve and a hand expansion valve for emergency use. A strainer is installed in the liquid line ahead of the controls. The hand expansion valve is generally installed in a line that bypasses the strainer, solenoid valve and thermal expansion valve. With this arrangement, any or all of these three units may be serviced without interrupting the flow of refrigerant to the cold storage room.

DESIGNED ROOM TEMPERATURES			
MEAT	15° F	MILK	40° F
FISH	15	BEVERAGES	40
FRUIT	40	BEER	35
VEGETABLES	40	WINES	45
DAIRY	35	ROOT VEGETABLES	45
THAW	45	FLOWERS	40
POULTRY	15	CORPSE	10
EGGS	35	ICE STORAGE	20
BUTTER	35	ICE CREAM	20
CHEESE	35		

Fig. 2. Temperatures used by the Maritime Commission in designing ship's stores systems.

Strainers are of the side outlet so that the baskets may be removed for cleaning without disturbing the piping connections.

In addition to these controls, any room equipped with an air cooler also has a suction pressure regulating valve to minimize frosting of the finned coil. A suction pressure gage is mounted for each suction pressure regulating valve.

A dual pressurestat is installed on each compressor. The low pressure switch is adjustable from 20 in. vacuum to 40 lb pressure and the differential is adjustable from 10 to 25 lb per sq in. The high pressure switch is set to open at about 150 lb per sq in and to reclose at 130 lb per sq in.

An automatic water regulating valve is usually installed on each condenser to regulate the flow of cooling water. The valves are actuated by the temperature of the Freon leaving the condenser. These valves are particularly valuable on shipboard since they relieve the crew of the necessity of frequent adjustments of hand valves that would be required for manual control.

Remember that the cooling water temperatures may vary over a considerable range as the ship crosses the Gulf Stream, enters or leaves a harbor or crosses the mouth of a river.

Many of the Commission's ships, notably the Liberty and Victory ships, are equipped with heat interchangers. The interchangers are used primarily to insure that no liquid is returned to the compressor. They generally have a seamless steel tube shell with two concentric helical seamless steel coils through which the liquid flows. A spiral deflector is placed within the inner coil to insure that the flow of the suction gas is turbulent. They are galvanized or zinc sprayed on the outside and tested to 250 lb per sq in with air under water. They are cleaned, dehydrated and sealed for shipment.

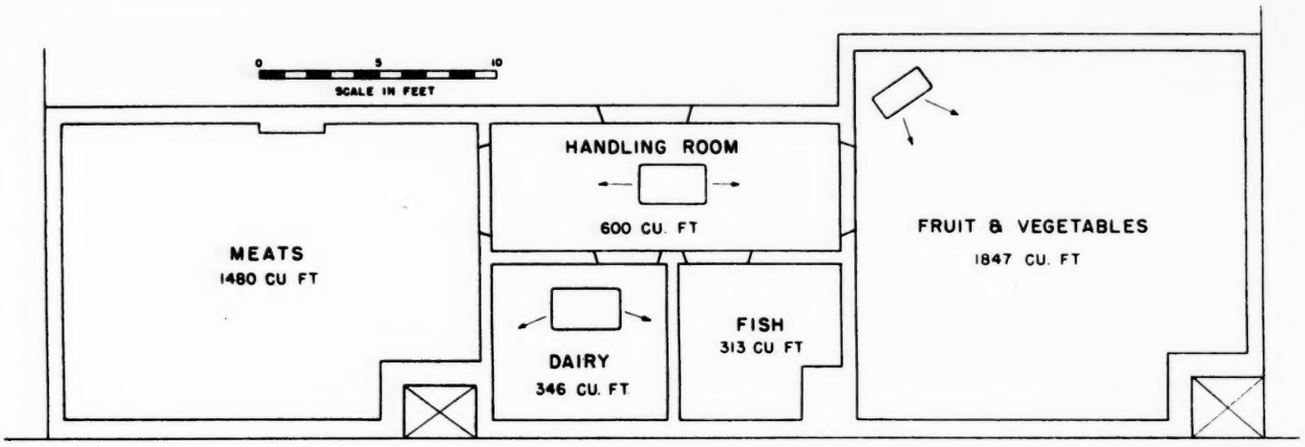


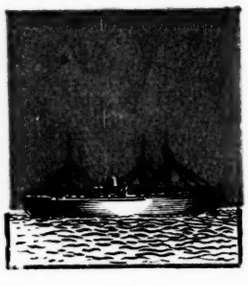
Fig. 4. Victory Ships have air coolers in the fruit and vegetable, dairy, and handling rooms, and pipe coils in the fish and meat rooms.

In general, all rooms that are maintained at a temperature above freezing are equipped with air coolers; and those that are maintained at a temperature below freezing are equipped with pipe coils. Both the air coolers and the pipe coils have seen radical changes in material in the last year.

Most of the air coolers are of the ceiling mounted type. Before the war and until copper and tin became critical materials, the cooling coils were constructed of copper and fins were of the same material. The entire coil assembly was electro-tin plated after fabrication. More recently, the tubes and fins have been made of steel. The tubes are either seamless drawn or Bundy type. The coil assembly is now hot dip galvanized after fabrication. The casing is of galvanized steel with a baked enamel finish. Access plates are arranged so that it is possible to service the coil readily.

Since few of the refrigerated rooms are large enough to require a duct system for distribution of the cooled air, the fans are usually of the propeller type. The fans are of zinc plated or zinc sprayed steel. In the event a duct system should be required, a centrifugal fan with V-belt drive would be installed.

Pipe coils used in the rooms that are held below 32F are now all of steel although in the past some have been made of copper tubing. The steel coils are made up from either 1 in. or 1¼ in. standard weight steel pipe. This is bent and welded into continuous lengths and then hot dip galvanized externally. The coils are supplied complete with bolted straps for bulkhead mounting; and each end is fitted with a coupling and copper tubing adapter. All coils must be carefully cleaned, tested, dehydrated and sealed before shipment.



Pipe, Valves and Fittings

All pipe for mains and connections is of seamless hard drawn copper tubing, Type K. Fittings are of the solder type of wrought copper or forged or rolled brass. Insofar as is possible, the tubing is bent in order to eliminate the use of elbows. The valves are of the diaphragm, packless type with forged brass bodies, phosphor bronze or stainless steel diaphragms, stainless steel springs, composition discs, screwed bonnets and have malleable iron or pressed steel handwheels.

All joints are made up with silver solder that has a melting point of from 900 to 1000F. Care must be taken in making up the connections to the valves to insure that the mechanisms are not damaged by this high temperature. Since the condensing temperature is usually at or slightly above ambient, the liquid lines are seldom insulated, but suction lines are covered with brine thickness cork.

Design Conditions

As to the conditions used as the basis of the design of a marine refrigeration system, we need mention only briefly the factors used in determining the refrigeration load. Wall transmission losses, ventilation and internal heat loads are calculated in a manner similar to that used for a comparable shore installation. One variation is that the marine engineer estimates his equipment load on 18 hours' operation out of 24. That is, after determining the total load, he increases this figure by 1/3. This extra capacity serves a dual purpose. First, it allows the ship's engineer, theoretically, six hours a day to service his equipment; and second, it provides the extra capacity necessary to take care of cooling down the food if it is loaded at a temperature higher than that at which it is to be maintained on shipboard. Cooling down is not much of a problem in the Meat or Fish Rooms because these products are loaded in a completely frozen condition, but fruits and vegetables are frequently loaded hot and impose a considerable load on the equipment.

Temperatures may be quite high on shipboard and loads are calculated using a minimum ambient of 100F. If the spaces adjoin the engine room, the ambient on that bulkhead or deck is considered to be 120F.

Let us now consider the types of rooms and miscellaneous equipment that are served by the ship's stores refrigeration system. Theoretically it would be possible to carry all essential refrigerated stores in two rooms, one held at 15F and one at 35-40F; but from a practical standpoint this would make a poor arrangement. There are two products carried at low temperature—meat and fish. While it might be possible to keep these two products in close proximity for a short time with no deleterious effects, it

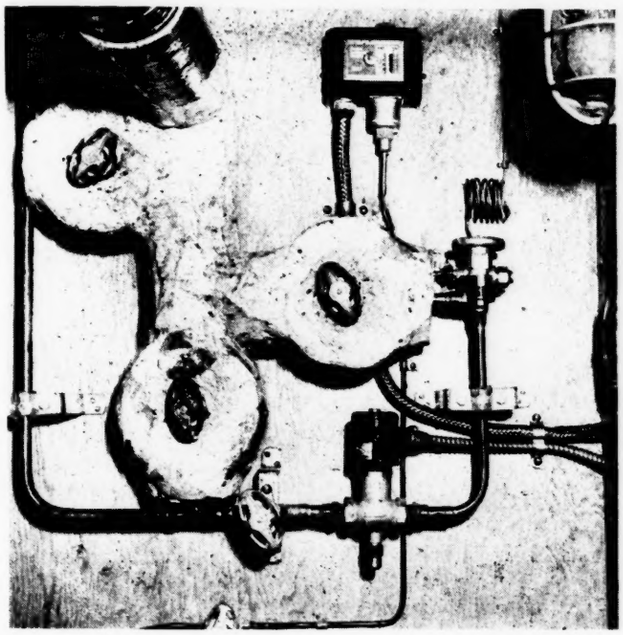


Fig. 6. Typical arrangement of room controls and piping when the pre-fabricated control cabinet is not used.

is poor practice to attempt to keep them together for the 60 or more days that a cargo ship is away from its home port. The same is true of the fruit, vegetables and dairy products that would necessarily be together in the 35F room. Dairy products in particular have the unfortunate faculty of absorbing flavors from other foods.

With these thoughts in mind, the Commission, insofar as is possible, provides a Meat Room, a Fish Room, a Fruit and Vegetable Room and a Dairy Room. On the larger ships separate rooms would be provided for fruit and for vegetables. There will also usually be a Thaw or Handling Room. This room is used for temporary storage of partially emptied crates or packages or of meat and also serves as a buffer between the cold storage rooms and the hot passageway into which the storage rooms open. When the Thaw or Handling Room is large enough, a meat block and various other fixtures are installed. By exercising proper judgment, most of the rooms can be arranged to open into the Thaw Room. This allows the steward to assemble at the outside door all of the food that he wishes moved to the galley at any one time. Then one opening of this outer door will remove the food and there will be a minimum of external heat load.

Fig. 5. A pre-fabricated control cabinet built by the Alco Valve Co., for one of the Commission's ships.

It must be kept in mind that the above applies to the cargo ships now being built. As mentioned above, no passenger ships are under construction at the present time. However, some of the storage spaces that must be added as it becomes more necessary to cater to the needs and whims of passengers might be listed. One of the first additions would be a room to store poultry separately from other meat. Then the Dairy Room might be divided into separate compartments for eggs, butter and cheese. There would be rooms for milk, beverages, beer, wines and root vegetables. On the largest liners there would be storage for flowers and for film; and even for the transportation of coffins. Then, too, there are the problems of ice and ice cream manufacture and storage, and of cooling drinking water. Fig. 1 illustrates the group of ship's stores rooms on a large luxury liner. The various galleys, pantries, etc., are located on decks above and the food is carried to the various levels by the elevator. The elevator is also used when the boxes are being loaded.

Not all of these services would necessarily be provided by one set of equipment. Many of these would be served by their own self-contained units. These larger systems may quite possibly be designed for operation with brine rather than for direct expansion. The temper-

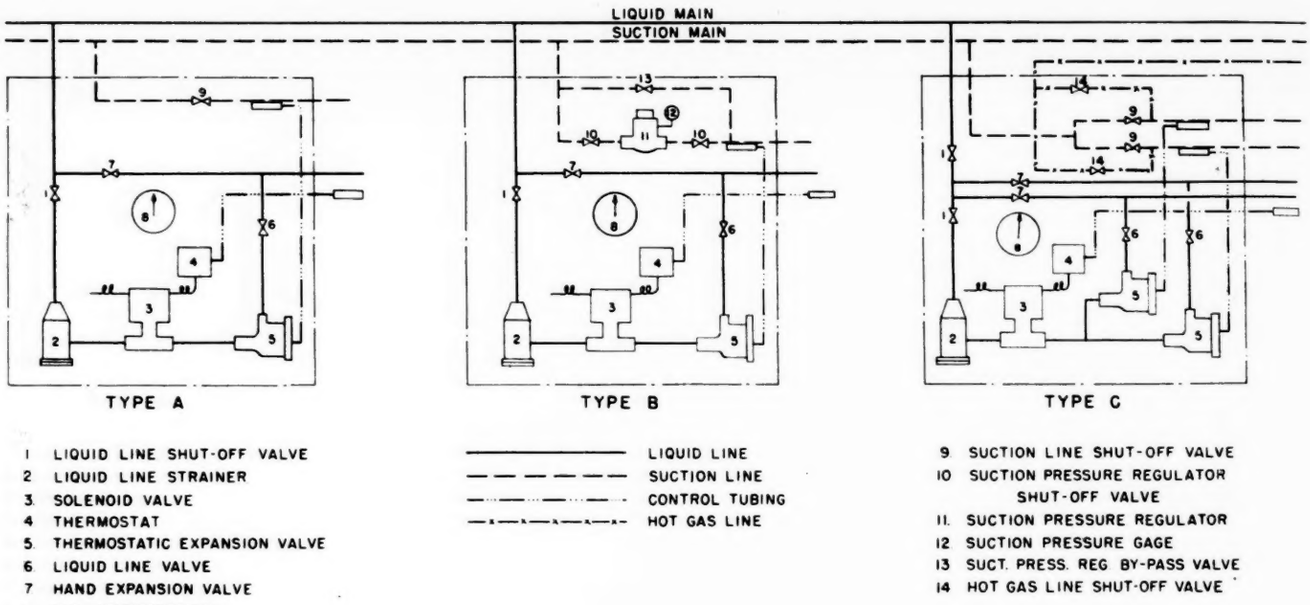


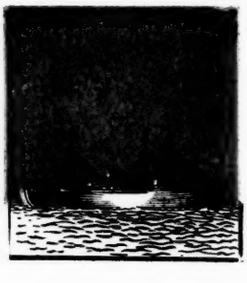
Fig. 7. Three different piping arrangements used for pre-fabricated control cabinets.

atures at which the spaces mentioned above would be maintained are shown in Fig. 2. These temperatures are somewhat lower than those formerly specified for the Commission's ships, but experience has taught that these lower temperatures are necessary today when voyages are greatly increased.

The problem today, however, is that of providing refrigeration equipment for the average cargo ship that has a Meat and Fish Room, each held at 15F; a Fruit and Vegetable Room at 40F; a Dairy Room at 35F; and a Thaw Room at 45F.

Water Cooling

Figs. 3 and 4 show typical arrangements of such a group of rooms. The Liberty ship installation, Fig. 3, has two additions to the standard rooms in the Scuttle Butt and the Ice Cuber. By way of explanation, a scuttle butt is nothing more than a means for cooling drinking water at a central location. Water is here cooled to a temperature of approximately 50F and then piped through the living quarters of the ship. On most of the Commission's ships where scuttle butts are used, the cooled water is circulated back to the scuttle butt; on the Liberty ship the water is not circulated. By using a circulating system, the amount of fresh water used is decreased appreciably by virtue of the fact that cooled water is available at the outlet at all times and there is no necessity for allowing the water to run until it gets cold at the outlet.



There is another use for cooled water on board ship, and that is in the Boiler Water Test Cooler. Drinking water outlets are provided in mess rooms, galleys and in the Engine Room.

Those cargo ships that have the quarters spread out over a considerable area or have the quarters divided into two groups, one amidship and one aft, are usually provided with self-contained drinking water coolers. These self-contained units eliminate the necessity of insulating long runs of piping. The units are of the air cooled type and are treated as completely independent installations in that complete spares are provided. On a passenger ship, despite the fact that the quarters cover a good percentage of the length of the ship, the cooled drinking water would probably be supplied from a circulating scuttle butt because of the tremendous number of outlets that are required.

The ice cuber indicated in Fig. 3 is capable of freezing 24 lb of ice in from 6 to 8 hours' time. It is usually located, as shown, in one of the refrigerated rooms in order to eliminate the necessity of insulating the ice cuber; and the Dairy Room is usually considered the best room because of the absence of food odors which might be absorbed by the ice while freezing.

Equipment Sizing

With the necessary room temperatures as shown in Fig. 2 in mind, let us consider the specific factors used to determine the size of the equipment. It is good practice to operate a direct expansion system with the compressor suction temperature about 20F below

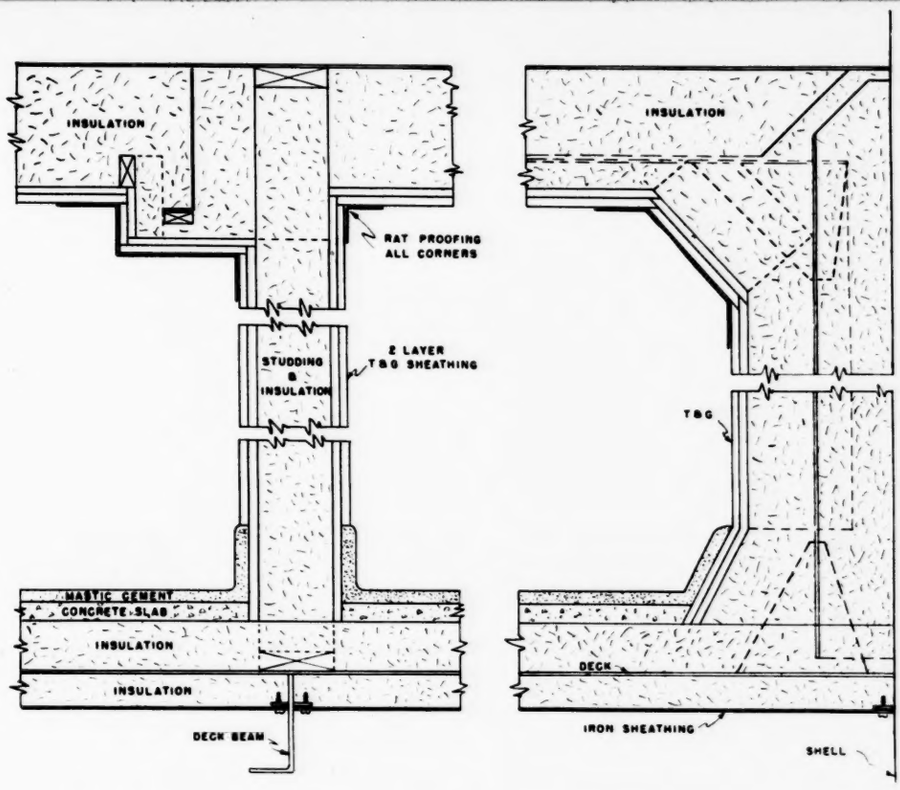


Fig. 8. Typical construction of refrigerated room walls. Note such interferences as the deep angle (upper left) and knee braces at the ship's side.

the temperature of the coldest room on the system. Therefore, since the Meat and Fish Rooms are held at plus 15F, it becomes necessary to use a suction temperature of minus 5F. If all rooms are connected to one compressor, this will result in some inefficiency since it means that the refrigerant for the higher temperature rooms is expanded to a lower pressure than is really economical. The alternative arrangement would be to have two compressors carry the load. One would operate at minus 5F suction and carry the Meat and Fish Rooms and the Ice Cuber; and the other would operate at plus 15F and would carry the Vegetable, Dairy, and Thaw Rooms and the Scuttle Butt.

There are other factors to be considered though, before we can definitely decide on a one- or a two-machine arrangement. These would include, first, the ratio of the loads to be carried by each of the two machines. If the two loads are approximately equal, then the two compressors can be duplicates and simply be equipped with different V-belt drives so that they will operate at the proper speeds to produce the required refrigeration. If, however, the two loads are quite different, it will probably mean that two different compressors will have to be furnished. This is not a good arrangement because of the necessity of providing two sets of spares for the compressors and for their motors.

Second, then, there is the problem of the availability of equipment. At the time that the Liberty ship was designed, this country was just beginning to get its production lines rolling. Therefore, it was decided that a one-machine installation would be more practicable than a two-machine installation; too, it must be kept in mind that the one-machine installation saves a motor. Motors have been a bottleneck in ship construction from the beginning of the Commission's accelerated program, because of the special construction necessary to withstand pitching, rolling and dampness aboard ship.

Third, there is the consideration of the space allotted in the ship to the refrigeration machinery. This is not a major factor because, if a two-machine installation is indicated by resolution of the other factors and the space originally allotted is not large enough, it is usually possible to move the entire refrigeration machinery installation to another location where there is sufficient room. But more about machinery location later.

Whether a single or dual arrangement is used, the condensing temperature is almost always 105F. This comparatively high figure is necessary because of the 88F condensing water temperature for which all marine installations are designed. This 105F is not an invariable, nor are the suction temperatures mentioned above. However, when the condensing temperature is decreased or the suction temperature increased, there are usually special circumstances that require these changes. The most common reason is that the refrigeration load has been increased after the machinery installation has been made. The machine will, of course, have an increased capacity at these new temperatures. Another reason for variations in the "standard" temperatures is the possibility of a saving in motor horsepower or in the size of compressor installed. Occasionally the standard temperatures will require a brake horsepower slightly in excess of a standard motor horsepower or require a piston displacement in excess of the displacement produced by the machine at its

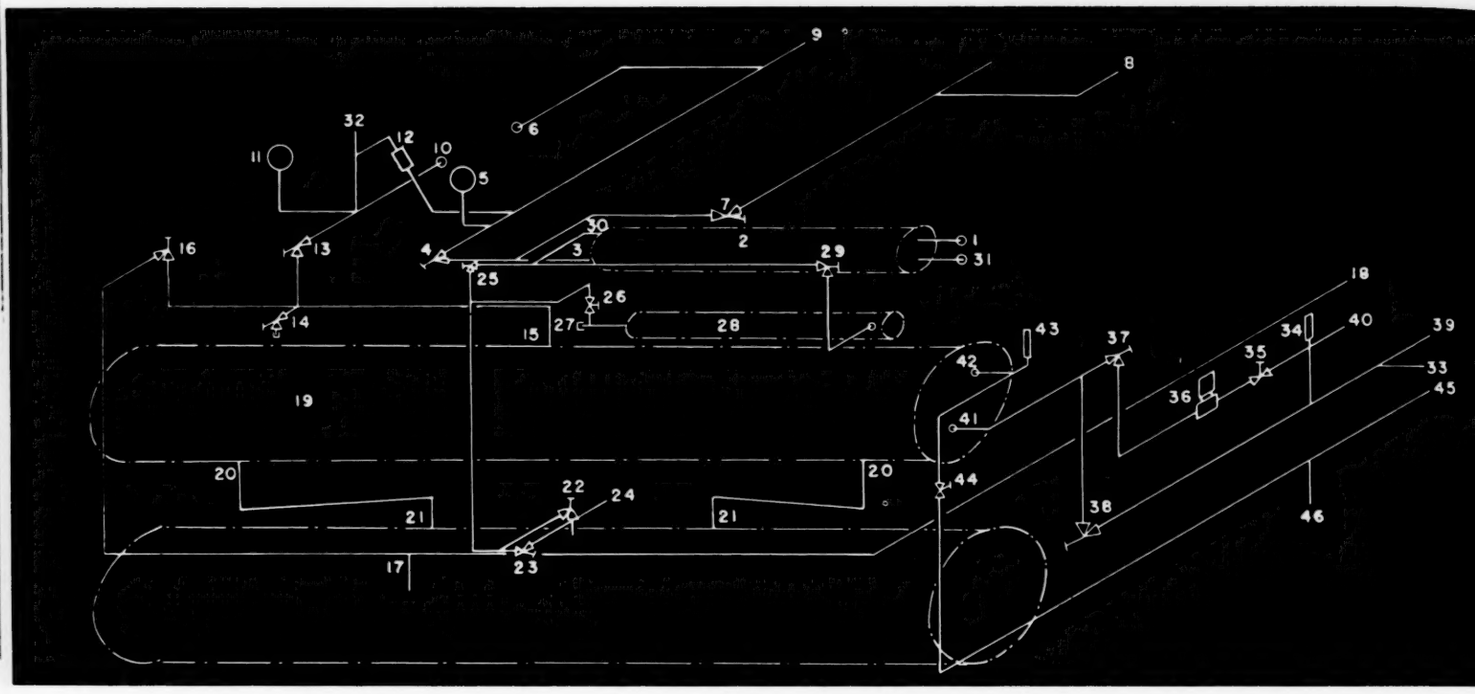
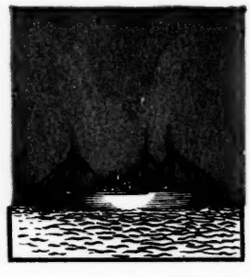


Fig. 9. Piping on Victory Ship pre-assembled unit. One-half is shown, other half similar. The connections shown are: 1—Suction from refrigerated spaces; 2—Heat Exchanger No. 1; 3—Gas outlet from Heat Exchanger; 4—Suction shut off valve; 5—Suction pressure gage; 6—Suction connection to Compressor No. 1; 7—Suction by-pass valve; 8—Suction connection to Compressor No. 2; 9—Suction by-pass from Compressor No. 2; 10—Discharge from Compressor No. 1; 11—Discharge pressure gage; 12—Pressure relief valve; 13—Discharge shut off valve; 14—Purge valve; 15—Inlet to Condenser No. 1; 16—Relief valve to refrigerant overboard dump; 17—Overboard dump connection; 18—Refrigerant from overboard dump relief valve on Compressor No. 2; 19—Condenser No. 1; 20—Condenser outlets; 21—Receiver inlets; 22—Main liquid shut off valve; 23—Main liquid line by-pass valve; 24—Liquid from receiver No. 2; 25—Liquid dehydrator by-pass valve; 26—Liquid shut off valve at dehydrator inlet; 27—Charging connection; 28—Liquid dehydrator; 29—Liquid shut-off valve at dehydrator outlet; 30—Liquid to Heat Exchanger No. 1; 31—Liquid to refrigerated spaces; 32—Hot gas connection to Meat Room; 33—Circulating water inlet; 34—Inlet water thermometer; 35—Water regulator shut-off valve; 36—Automatic water regulator; 37—Water regulator shut-off valve; 38—Water regulator by-pass valve; 39—Water by-pass to Condenser No. 2; 40—Water to Condenser No. 2; 41—Water inlet to Condenser No. 1; 42—Water outlet from Condenser No. 1; 43—Outlet water thermometer; 44—Water outlet shut-off valve; 45—Water outlet from Condenser No. 2; 46—Circulating water overboard discharge.

maximum allowable speed. Good sense would then dictate that the designing engineer alter either the suction temperature or the discharge temperature or both in order to be able to use the standard motor or smaller machine.

The condensing temperature cannot safely be lowered below 98F. A 10F temperature differential between the condensing temperature and the maximum expected circulating water temperature is an absolute minimum. Another reason for using a 105F condensing temperature is that the ambient in which the machinery operates can be expected to reach 100F frequently. Any designed condensing temperature below ambient is to be avoided. The principal objection to increasing the suction temperature is that the consequent decrease in difference between the 15F desired room temperatures and the new suction temperature may, and probably will, result in an increased room temperature.



Let us return for a moment to the question of the number of machines to be installed. So far we have been concerned with the machines that are active in carrying the load. There is also the possibility that it may be considered necessary to install standby equipment, and this decision will be reached independently of the decision that a one- or two-machine arrangement is more satisfactory. If a single machine is to carry the load, and a standby machine (and, of course, its condenser, receiver, dehydrator, etc.) is to be used, then the standby will be an exact duplicate of the active machine. In addition to the safety factor provided by the standby equipment, it can be piped so that when the rooms have been freshly loaded with food, the regularly active machine can serve the rooms below freezing and the standby machine can serve the balance during the cooling down period. Then, after the rooms and food have been brought down to their holding

temperatures, the standby machine is cut off the line and the entire cooling load is carried by the active machine.

If a dual machine installation is provided, there are two possibilities in standby arrangement. The first would not require an extra machine, but the two machines would be large enough that they would run at only about seventy-five percent full capacity when carrying the normal load. An extra set of V-belts and pulleys that will operate either machine at its maximum allowable speed is provided. Then, in the event that a breakdown occurs, this special set of belts and pulleys is installed on the machine that is still in service. The whole load is then piped to this one machine and there will be adequate time for the crew to repair the other. This arrangement will probably not provide enough refrigeration to keep all the rooms at their designed temperatures, but by adjusting suction and discharge conditions and by making use of the fact that the compressors were originally designed for only 18 hours' operation out of 24, reasonably good room temperature can be expected.

The other alternative in the case of the dual machine installation is to provide standby equipment equivalent in capacity to the larger of the two machines ordinarily operating. This is a better arrangement but slightly higher in first cost. The standby machine would be piped so that it could provide standby service for either of the two active machines.

Standby Equipment

Several times during the foregoing, mention has been made of the spare parts that are carried on every ship. Spare parts would be provided whether or not standby equipment is installed, although the presence of the standby equipment would allow the number of spare parts to be decreased. These spares are divided into four separate groups. The first of these groups is that for the compressor, and a typical list of spares would be one each of the following: Complete connecting rod assembly; piston and suction valve assembly; complete set of piston rings for one machine; discharge valve plate assembly; shaft seal assembly; complete set of gaskets for one machine; complete set of main bearing bushings; compressor relief valve; complete charge of lubricating oil for each machine; and complete set of V-belts of each size.

Spare parts required for the condenser would be as follows: 10%-tubes for one condenser; two sets of gaskets for one condenser; a tube expander; and a tube beller tool.

The third group depends somewhat upon the type of piping system that is installed, but would contain essentially: A dehydrator cartridge in moisture tight sealed container; three dehydrator flange gaskets; a gage, each size and type; a thermometer, each size and type; a dual pressurestat; a strainer basket, each size; three strainer flange gaskets, each size; a room thermostat; three solenoid coils; a solenoid valve cage assembly; two gaskets each size and type for solenoid valves; one thermal valve power assembly; a thermal valve cage assembly, each size; two gaskets each size and type for thermal valves; a suction pressure regulating valve, each size, complete except for lower body gaskets; two gaskets each size and type for each size suction regulator; a set of spares for each size and type line valve, to include lower bushing assemblies, diaphragms, gaskets and seats; a complete charge of Freon-12 for the system, in 145 lb drums; a complete spare motor for each size room air cooler motor; and an internal unit for each size room cooler motor switch.

The last group of spares is that for the motors and controls, which would be as follows: A field coil of each size and kind; a set of bearings of each size and kind; a complete brush holder of each size and kind, with three spare springs and stud insulation; a set of brushes of each size and kind; a complete set of contact elements for the controls; a complete set of springs; shunt magnet coil of each size and type; a set of overload heaters; and a resistor unit of each size and type.

In the event that no standby equipment is provided, there would be some additions to the foregoing. These would include a crankshaft for the compressor and an armature for the compressor motor.

At first glance, the quantity of spares carried on a ship may appear excessive, but there are a great many factors that enter into the Commission's decision to provide them. After all, the health and well-being of from fifty to eighty men depend upon the proper functioning of the refrigeration machinery. If a breakdown should occur when the ship is at sea or in a remote port, it is very important that the chief engineer have at his disposal a sufficient quantity of spare parts to make rather extensive repairs. Then, too, there is the fact that, with the limited machine tool equipment provided, there is little chance that the crew will be able to fabricate or improvise a replacement part.

Prefabricated Control Cabinets and Units

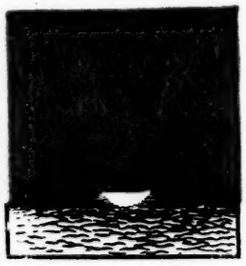
There are two innovations that the Commission has adopted recently worthy of mention here. One is a prefabricated room control cabinet and the other is a pre-assembled machinery unit. Neither is original with the Commission, but it is believed that the Commission is the first to use these ideas in cargo ship installa-

tions. Both of these innovations were adopted in an effort to save man hours of labor in the shipyard and to save money on the overall installation cost. Naturally facilities for assembly of controls, pipe, valves and fittings are better in the refrigeration manufacturer's shop than on shipboard. Therefore it is advantageous to do as much of this work as possible before the equipment is shipped. Then, too, there is the fact that skilled labor is at a tremendous premium in shipyards today and any burden that can be removed from the yards is distinctly worth while even if there is no saving in cost.

Fig. 5 illustrates one of the prefabricated control cabinets, while Fig. 6 shows the way a set of controls is installed when the prefabricated cabinet is not provided.

All of the controls for any one room can be contained in a cabinet 24 in. square by 6 in. deep. Since the purpose of these cabinets is to have all the controls assembled by the refrigeration equipment supplier before shipment, the suction gas line is brought back through the control cabinet so that the thermostatic expansion valve bulb can be permanently installed. The cabinets are arranged for flush mounting and are constructed with a two inch flange extending completely around the outside. This flange is drilled and provided with a gasket that will insure a moisture tight bulkhead connection. The cabinets are constructed of twelve gage steel and have a hinged door of either wire mesh or expanded metal. The door is provided with a snap lock that requires the use of a key and that will relock automatically when the door is closed. All locks on a ship's set of cabinets can be opened with one key. This construction allows inspection of the controls and particularly the thermometer, but at the same time prevents tampering by an unauthorized person.

Whenever possible, all Freon piping connections, together with the thermometer and thermostat tubes, are brought out the back of the cabinet as close together as is practicable. Fig. 5 illustrates a cabinet for an ice room and since the room and cabinet are on the same side of the bulkhead on which the cabinet is mounted, the connections were brought out the top of the cabinet. All connections are sealed where they pass through the cabinet in order to maintain the moisture tight integrity of the bulkhead. The thermometer and thermostat stuffing tubes are so constructed that the bulbs may be withdrawn separately for inspection or replacement. All of the controls and the valves and piping within the cabinet are adequately supported and the cold pipes are carried on insulated brackets, with cold pipes insulated to eliminate sweating as much as possible. The connections extend from six to eight inches beyond the wall of the cabinet and are shipped with all pipes protected by metal caps that are soft-soldered in place.



Cabinets are shipped completely assembled except for the dial thermometers. The thermometers are not installed before shipment because of the long length of capillary tubing that must be provided. This capillary may be as long as twenty feet and is best installed by the shipyard after all other connections have been made. The yard mechanics have only to mount the thermometer on the three clips provided, push the armored capillary through the back and pack around the capillary with insulation. Insofar as is possible, all cabinets are kept close together and each is identified by a label plate indicating the room or piece of equipment to which it is connected.

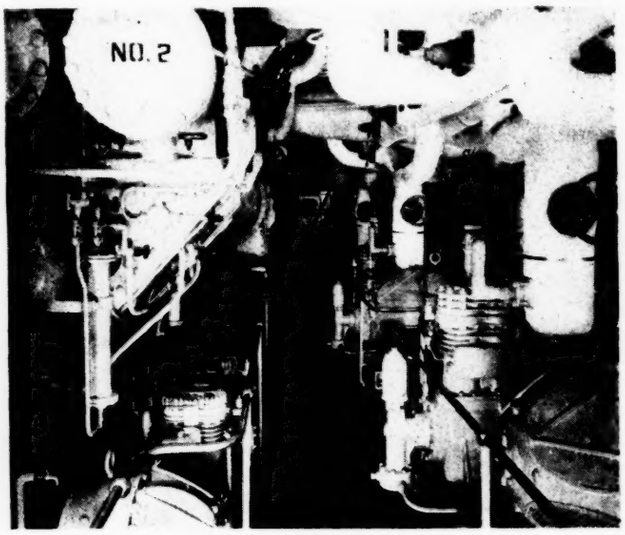


Fig. 10. Right, four Carrier compressors for cargo refrigeration; left, two smaller compressors for ship's stores service.

Fig. 7 illustrates three arrangements of controls and piping that will accommodate any of the rooms in a typical cargo installation. A cabinet of Type A would be used for a room that is cooled by pipe coils and is held at a temperature above freezing; Type B would be used for a room held above freezing and cooled by an air cooler; and Type C would be used for a room held below freezing and cooled by pipe coils. The Type C diagram illustrates an arrangement for a room that requires two refrigerant circuits. It also illustrates the connections used for hot gas defrosting that is provided for the Meat Room. The Type A cabinet would also be used for spaces to be held below freezing if no hot gas defrosting is required; or, with the elimination of the thermometer, it could be used for an Ice Making unit.

A special feature of the design of the

Type C cabinet is that the hot gas used to defrost one of the coil circuits can be expanded in the other coil circuit, thus eliminating the necessity of piping the defrosting gas to another room for expansion.

Wall and Floor Insulation

A reference to Fig. 8 will give the reader some idea of the general construction of the walls of a refrigerated room on board one of the Commission's cargo ships. The construction is not particularly different from the construction used in an ordinary land installation except for two details. The rooms aboard ship are in general more sturdily built than are land boxes. This is necessary because of the fact that bulkheads are continually working when a ship is at sea. This is particularly true of those bulkheads that are parallel to the centerline of the ship. It is imperative that the room walls be kept as tight as possible; hence the heavier construction.

The other difference is in the manner of applying the insulation on the floor. On a great many ships the refrigerated rooms are located on a deck that partially covers the engine or boiler room. This location will almost invariably make for very high ambient temperature under the refrigerated spaces and create the need for a considerable thickness of insulation. Deck heights seldom exceed nine feet and are often only eight and a half feet. Since the ceiling construction will frequently require as much as twelve inches, and in order to maintain a minimum clear height in the rooms of seven feet, it is not unusual to put a part of the floor insulation on the under side of the floor. This is indicated in Fig. 8.

Before the war limited the supply and before this country started the mass production of ships, the Commission used corkboard almost exclusively to insulate the refrigerated spaces. Now, however, in order that there be enough insulation to meet all demands we are using specially prepared rock or glass wool. While these materials are somewhat more difficult to install, they do have the advantage of being fireproof and this is particularly important today. Corkboard is still used in the floor construction because it provides a better base for the concrete and mastic.

Machinery Location

Location of the refrigeration machinery is of considerable importance on shipboard. The best location from the standpoint of ambient temperature and of inspection by the engineering force would be the floor of the engine room. Unfortunately, however, it is not unusual for the layout engineer to discover, when he comes to locating the refrigeration machinery, that the main propulsion machinery and larger auxiliaries have taken up all the space available on the engine room floor. His next choice is a flat or partial deck that will be located anywhere from ten to fifteen feet above the floor. This location is satisfactory from the inspection standpoint but is often unsatisfactory from the standpoint of ambient temperature. This is true particularly when such heat producers as evaporators, steam pumps, or feed heaters are situated immediately beneath the refrigeration machinery.

The next possibility is to locate the refrigeration machinery just outside the engine room and on the deck adjacent to or immediately below the refrigerated spaces. Such a location penalizes the inspection angle somewhat but assures that the machinery will have a satisfactory temperature in which the unit could operate.

It should be kept in mind that a high ambient temperature not only causes condensing temperature trouble but also affects the V-belts and motors. To guard against these high ambient temperatures particular care is exercised in developing the ventilation system to insure that there is a plentiful supply of fresh air at the refrigeration machinery location, whether this location is in or out of the Engine Room.

Victory Ships

Because of the unusual interest that has been exhibited in the Victory Ship, we believe it worth while to devote some space to the details of the refrigeration installation on this newest of the Commission's designs. Since this is a ship that is to be mass-produced in several shipyards on the East, West and Gulf Coasts, a great deal of thought was given to the simplification of construction work to be done by the yards. The prefabricated control cabinets had been used before and were adopted for this ship. The Commission's Design Agent, George G. Sharp, thought it worth while to investigate the possibilities of a pre-assembled set of equipment. Thus was developed the unit mentioned above. In the Victory Ship installation, the pre-assembled machinery unit has a value other than that of the saving of installation time and cost. When the ship design was in its early stages, the Commission decided to have at least two, and preferably three, sources of supply for each piece of equipment to be used. This would naturally lead to a certain amount of difficulty in establishing a common basic design for some parts of the refrigeration installation such as the compressors, condensers, and receivers. Since the time available for development before actual manufacture started was extremely short, it seemed

doubtful that the three manufacturers selected would have enough time to tool up to produce identical equipment. Hence, the other reason for the use of the pre-assembled unit.

With this machinery unit there is no necessity of having all component parts of all units identical. After the location and size of all piping connections at the outside of the unit and the location of the bolting down holes in the base were established, each manufacturer would be free to make use of the space within the unit as he saw fit. The only other limiting factor was that all equipment that might need servicing must be at the periphery of the unit.

Several preliminary conferences were held for the purpose of establishing the approximate dimensions required and the size and location of piping connections. When the problems of interferences, clearances, etc., had been settled, the work of developing the details of the unit was assigned to the York Corporation. The unit, as it has been finally developed, requires a deck space of 5 ft 10 in. x 5 ft 10 in., and the dimension from the bottom of the base to the highest point, the top of the compressor, is only 3 ft 5½ in. The small amount of deck space required allows the machinery to be installed on the engine room floor.

In order that each of the three manufacturers' equipment be exactly alike as far as the shipyards' installation problems were concerned, there were two other major parts of the design that had to be developed. These were the control cabinets and the piping and room equipment. The first of these was assigned to the General Electric Company and the second to the Carrier Corporation. The close cooperation between these three manufacturers and the naval architect has made possible the rapid and efficient development of the complete installation.

It might be well to mention here that it is the Commission's practice to require that the refrigeration equipment manufacturer design and supply all of the piping, including mains, pipe coils, valves, fittings, etc., in addition to the main machinery. All plans are checked by the naval architect and the Maritime Commission before fabrication is started.

Some departures from the Commission's previous practice were required in order that the unit be made as compact as possible. As mentioned above, the receivers on shipboard are usually mounted vertically. For this pre-assembled unit, however, it was necessary to arrange the receivers horizontally. If this had not been done, the unit would have been at least two feet higher and would have occupied additional valuable deck space. Too, the unit would have been harder to handle in shipment and would have required a heavy structural steel frame.

The receivers have flat heads instead of the customary concave heads. The entire unit is supported by a pair of channels that are arranged with the flanges facing the outside of the assembly. Holes are cut in the web of the channels large enough for the receivers to pass through and the ends of the shells are in line with the outside edge of the flanges. The shells are welded to the channel webs to insure a structural base of adequate strength and rigidity. Several cross ties are provided between the channels so that the two compressors and their motors will have adequate support. The condensers are carried on straps attached to the tops of the channels.

Fig. 11. Hold space served by the Carrier equipment shown in Fig. 10. Controls are mounted around the insulated stanchions.

Another departure from previous practice is the arrangement of the refrigerant overboard dump line. Heretofore, this line has been kept tight only by the pressure relief valve. This has been generally satisfactory, but there have been some reports of the valves leaking and allowing a considerable amount of refrigerant to escape before the trouble was discovered. With Freon becoming increasingly more critical, it was obviously necessary to eliminate this condition so that the ship's spare supply of refrigerant would not be used up. It was finally decided to install a breaking disc in the overboard discharge line ahead of the relief valve. This disc is accurately calibrated at 300 lb per sq in and its location serves to keep the pressure off the relief valve.

In the desire to insure that the entire refrigeration installation on the Victory Ship will be the best possible, there are several other features that have been incorporated in the design. One is a refinement of

the pressurestats that are mounted on each compressor. A high pressure lock-out device has been added to the conventional dual pressurestat. If the compressor shuts down because of high pressure, it will not start up again until a re-set button has been pressed. A long shut-down period will attract the attention of the crew and the cause of the high pressure operation will be determined and remedied.

Another feature of this installation is the use of air coolers in the Dairy and Handling Rooms. On most ships these two spaces are cooled by pipe coils. In the Victory Ship Handling Room most of the available wall space is taken up by doors. Ceiling coils are to be avoided if possible, and so an air cooler has been provided. The Dairy Room has been provided with an air cooler to increase available space for storing supplies.

The arrangement of machinery is such that both machines are on the lines to carry the load. One machine is piped to the Fruit and Vegetable, Dairy and Handling Rooms; and the other machine handles the Meat and Fish Rooms. Neither a scuttle butt nor an ice cuber is provided. Cooled drinking water is furnished by individual drinking water coolers, each of which is served by its own air cooled equipment. Ice is provided by the freezing units in each of the separate galley refrigerators. A reference to Fig. 9 will reveal that the two sets of equipment are cross connected in such a way that the entire load can be connected to either machine.

Up to this point we have been concerned entirely with the equipment installed for use with the ship's stores boxes. Some mention should be made of the installations used for the preservation of refrigerated cargo, although the details of this type of installation are not within the scope of this article.

The equipment used in a cargo refrigeration installation is quite similar to that used for ship's stores. Air-cooled, reciprocating compressors have been used in most cargo installations, as shown in Fig. 10. One notable exception to this generality is the installation of centrifugal compressors on one group of ships that were designed to carry frozen meat.

The Commission has built a comparatively small number of totally refrigerated ships, but has equipped a great many ships with four or more refrigerated hold spaces. One of these hold spaces will have a volume of from 25,000 to 35,000 cubic feet before insulation and fittings are installed. A hold space may be all one large room, but is more usually divided into two or four equal rooms. Most of these systems have been designed to carry the refrigerated holds at any temperature from 0F to 55F. In these installations, cooling is usually accomplished by both wall and ceiling coils and air circulation is provided by a fan and duct system. The fan is seldom if ever used when the cargo is carried at a temperature of 25F or below.

Some of the ships have been designed only for carrying bananas or other fresh fruit, and, of course, these systems do not require holding temperatures below freezing. Most of these "banana" ships are provided with air cooling systems rather than pipe coils. Fig. 11 shows a cargo hold designed for carrying bananas. Cooled air is supplied from ducts located at each side of the room underneath the wood gratings.

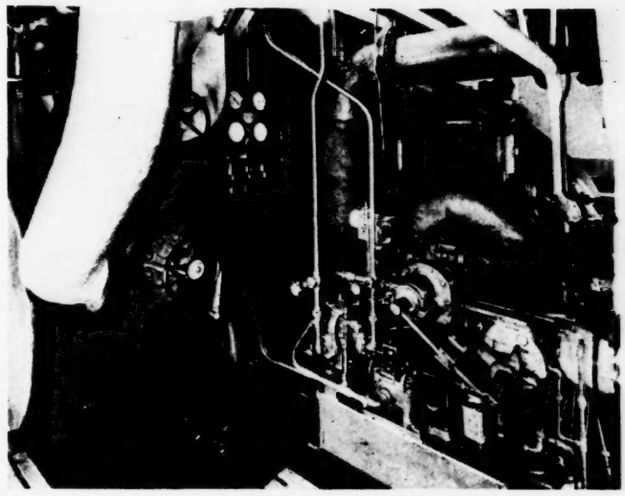


Fig. 12. Engine room of "Blue Jacket" showing York compressor and turbine. Ship, a converted C-2 freighter, will transport frozen meats for Allied armies. This is said to be first use of centrifugal refrigeration on any cargo vessel.

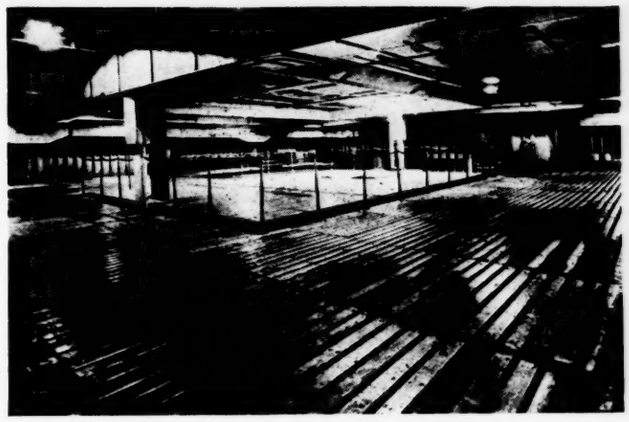


Fig. 13. Converted freighter "Blue Jacket" has 35,000 cu ft of refrigerated cargo space.

REFRIGERATION BUILT BY

By H. M. HENDRICKSON
Assistant Branch Engineer, York Corporation
Los Angeles, Calif.

ADMIRAL LAND, Chairman of the U. S. Maritime Commission, recently announced that the shipbuilding industry of the United States had completed 1,200 merchant vessels of 10,000 average tonnage each, during the first 8 months of 1943. This rate of 150 large ocean-going vessels per month, or 5 per day, is the fastest shipbuilding pace of any nation at any time, and is almost unbelievable. One of the most important contributors to this shipbuilding miracle has been the Consolidated Steel Corp., Ltd., with shipyards at Wilmington and Long Beach, Calif. Recipient of the Maritime Commission "M" and gold star for excellence in performance, the Consolidated Steel Corp., Ltd , has concentrated on the production of U. S. Maritime Commission deluxe type C-1 cargo and passenger vessels, besides building hospital ships, troop transports, escort vessels, etc., as required by the exigencies of the war effort.

All vessels which ply regular trade routes in coastal, inter-coastal, or international shipping require refrigeration facilities for carrying perishable foodstuffs needed for passengers and crews. In addition, some ships have one or more holds provided with equipment for carrying refrigerated cargo. In general, refrigeration requirements for merchant vessels fall into the following classifications:

1. Ships stores:
   (a) Cold storage compartments
   (b) Water cooling
   (c) Ice making
2. Refrigerated cargo holds
3. Self-contained refrigerators for galleys, pantries, etc.

The first four C-1 vessels constructed during 1941 by Consolidated Steel were equipped with one refrigerated cargo hold as well as with ships stores refrigeration. Fig. 6 and Table 1 illustrate the general arrangement and refrigeration capacities provided for ships stores. Similarly, Fig. 9 and Table 2 give data covering the refrigerated cargo hold. In Table 2 note that, although the cargo compartments are designed for various products at different cold storage temperatures, they are all piped the same, with refrigeration capacities so that any or all compartments can be maintained at the lowest cold storage temperature. This is to give the refrigeration flexibility so that any diversification of refrigerated cargo may be accommodated. Since our entrance into World War II, the refrigerated cargo has been discontinued on the C-1 vessels constructed at Consolidated Steel, and ships stores refrigeration only has been provided together with self-contained refrigerators for galleys, pantries, and so on.

TABLE 1.—SHIPS STORES REFRIGERATION

Space	Gross Volume, Cubic Feet	Temperature of Space, F	Cooling Unit or Evaporator	
			Lineal Ft, 1 In. Pipe	Sq Ft of Pipe Surface
Meat	650	22 to 26	350	121
Vegetables	900	35 to 40	Fan Cooler	...
Dairy Products..	175	32 to 40	125	43
Fish Products ..	125	20	150	52
Ice Storage	125	20	125	43
Thaw Room	610	45 to 50	150	52

Insulation

Insulation for the refrigerated compartments is largely glass wool batts having an insulating value approximately equivalent to corkboard of the same thickness. Glass wool and similar fireproof insulating materials are largely used instead of corkboard because of increased fire danger from bombing in war times, the temporary shortage of corkboard, and the increased use of welding in present day shipbuilding. Some of the insulating materials which have been tested and approved for refrigerated compartments on ships by the Maritime Commission are:

Johns-Manville Bx-4M, 4 lb density.

DETAILS OF C-1 CARGO SHIPS CONSOLIDATED STEEL CORP.

Shipyards of the Consolidated Steel Corp., at Wilmington and Long Beach, Calif., fly the Maritime Commission "M" and a gold star for excellence in performance. Refrigeration practice at these yards is described by the author who is closely identified with the work in these yards which have concentrated on deluxe C-1 vessels as well as on transports, hospital ships and escort vessels.

Tuco Products, TP2 Zerocel, 4 lb density.
Eagle Picher, Eagle Felt M2, 4 lb density.
Owens-Corning Fiberglas, Type PF Marine Insulation (with binder), 4 lb density.
Owens-Corning Fiberglas Marine Insulation (without binder), 4 lb density.

Corkboard, however, is used on the C-1 vessels for insulating the floors as it will stand up well under heavy loadings. The corkboard is laid in hot asphalt in at least two layers with all joints staggered. Over the corkboard is poured a concrete floor at least 1½ in. thick with reinforcing in the concrete of No. 18 gauge heavy mesh expanded metal. A wearing surface of heavy duty asphalt mastic at least 1 in. thick forms the finished floor. At the junction of the deck and sidewalls, a 6 lb sheet lead flashing 18 in. wide is installed before the mastic floor is poured. The lead is flashed up the sidewalls 9 in., and extended out along the deck 9 in., with all joints well soldered.

The thickness of the insulation depends upon the temperatures to be maintained. In all cases the insulation is installed in two or more layers with all joints staggered between layers. The insulation thicknesses used on shipboard are somewhat heavier than generally used in land work for the same refrigerated space temperature. Structural difficulties in ship construction generally make it necessary for steel stiffeners, braces, and deck beams to project into the insulation, thus reducing the overall insulating efficiency. Table 3 gives minimum insulation thicknesses (exclusive of sheathing, linings, etc.) for various cold storage temperatures, and is representative of good marine practice.

For refrigerated cargo compartments, the interior walls and ceilings are finished with two layers of ⅞ in. T & G spruce sheathing with two layers of waterproof building paper between the insulation and the first layer, and two additional layers of waterproof building paper between the two layers of sheathing. The exposed surface of the sheathing is painted with two coats of orange shellac.

For ships stores compartments, the interior walls and ceilings are finished with one layer of ⅞ in. T & G spruce sheathing with two layers of waterproof building paper between the insulation and the sheathing. Then the sheathing is entirely covered with a No. 22 gauge galvanized sheet metal lining with all joints soldered.

All exposed corners of refrigerated compartments, both internal and external, are fitted with 6 in. x 6 in. No. 18 gauge galvanized sheet metal angles for rat proofing. All pipe lines or conduits entering the compartments are fitted with galvanized iron collars

TABLE 2.—SHIPS CARGO REFRIGERATION

Space	Gross Volume, Cubic Feet	Temperatures—F		Cooling Coils	
		Space	Suction	Lineal Ft 1¼ In. Pipe	Sq Ft of Pipe Surface
Frozen Meats No. 1	4,820	0	— 15	2,410	1,478
Frozen Meats No. 2	4,820	0	— 15	2,410	1,478
Precooled Fruits and Vegetables	4,820	35	+ 25	2,410	1,478
Hot Fruit and Vegetables	4,820	45 to 55	+ 35 to 45	2,410	1,478

where the insulation is pierced. All openings in air ducts and machinery (such as ventilating holes in motor end bells) are suitably covered with wire mesh screen. This rat proofing is required by U. S. Department of Health regulations.

Wooden gratings of 2 in. x 2 in. or heavier material are fitted to the floors of all refrigerated compartments, except where cargo is suspended. The gratings are arranged in panels for easy removal and permit air circulation under the cargo, but can be removed for cleaning when the cargo is unloaded. All walls, cooling coils, ducts, and other equipment are protected from injury when stowing cargo by 1½ in. x 2 in. or heavier wooden cargo battens spaced on about 12 in. centers. Battens in front of cooling coils are in portable sections for servicing coils.

U. S. Maritime Commission specifications require that specified temperatures be maintained in the refrigerated spaces with an ambient temperature of 100F. They further provide that the insulation must pass the following test for efficiency: With all refrigerating machinery shut down, doors closed and compartment empty, the temperature rise from the minimum specified compartment temperature shall not exceed an average of 2F per hour over a period of six hours with an ambient temperature of 85F. This test is made after the space or spaces have been brought down to the specified temperatures with the refrigerating machinery operating, and held there for a 24-hour period.

Load Calculations

The design outside temperature is taken as 100F for all refrigerated compartments. Outside temperatures as high as 120F may be encountered on some trade routes, but refrigeration equipment is seldom designed for higher than 100F outside. However, equipment is selected to carry the design load with 18 hours operation in each 24, so that a temporary overload can be carried with a longer operating period.

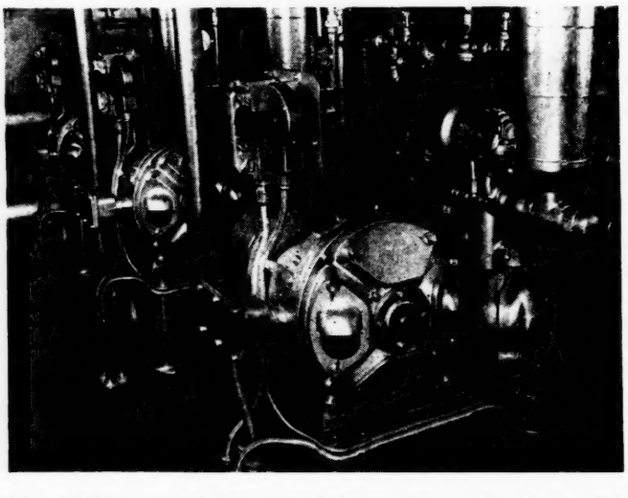


Fig. 1. Three of the five York Freon-12 condensing units with marine-type motors and controls; condensers and receivers mounted on bulkhead.

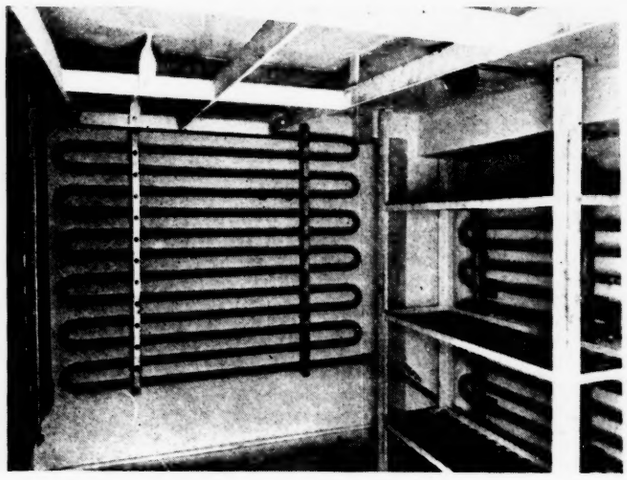


Fig. 2. Interior of meat compartment showing wall coils, shelving and meat rails.

The heat leakage can be figured on the basis of the outside compartment surface taken at 100F minimum temperature, and using a k value for the insulation corresponding to the equivalent thickness of corkboard. For practical purposes the k value can be taken as 8 Btu per sq ft per 24 hours per degree F temperature difference per inch of thickness. This transmission factor allows for reasonable deficiencies in the insulation from interference with structural steel members of the ship projecting into the insulation. Service loads and usage factors are generally very low since refrigerated compartments are seldom opened during a voyage except in the case of ships stores. Opening of the latter, too, is restricted to certain short periods of the day during the preparation of meals. A service and product load factor of 1 Btu per sq ft of outside compartment surface per degree F temperature difference per 24 hours is an amply safe allowance for losses due to door openings, people, lights, and product cooling under the most severe service occurring on shipboard. However, in the case of ships cargo refrigeration, there is sometimes a considerable internal load to be considered, especially when hot fruit or vegetables are loaded in the compartments.

Refrigerating Machinery

The old carbon dioxide and ammonia refrigeration systems which were standard equipment for Navy and merchant vessels during World War I are now practically obsolete. Dichlorodifluoromethane (Freon-12) refrigerant is now used almost universally on American ships for both the Navy and the merchant marine. Carbon dioxide equipment is no longer used because of the high operating pressures, requiring extra heavy piping and machinery. Ammonia has not entirely disappeared as a refrigerant for cargo vessels, but its use is discouraged in favor of Freon-12 which is a much safer refrigerant.

All equipment must be furnished in accordance with the latest rules of the American Bureau of

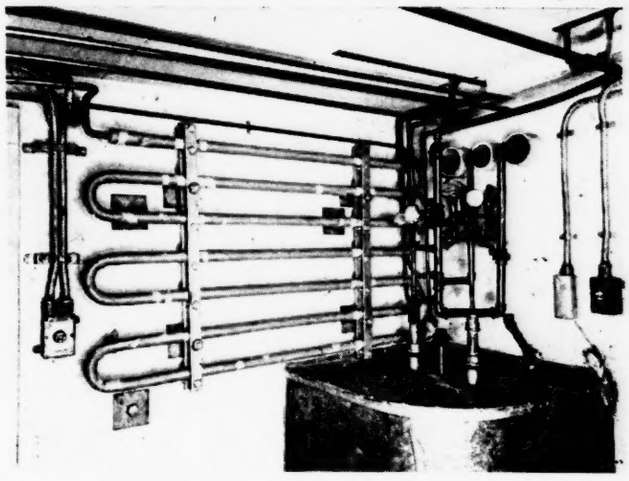


Fig. 3. Another view of thaw compartment showing scuttle butt, with single wall coil and expansion valve

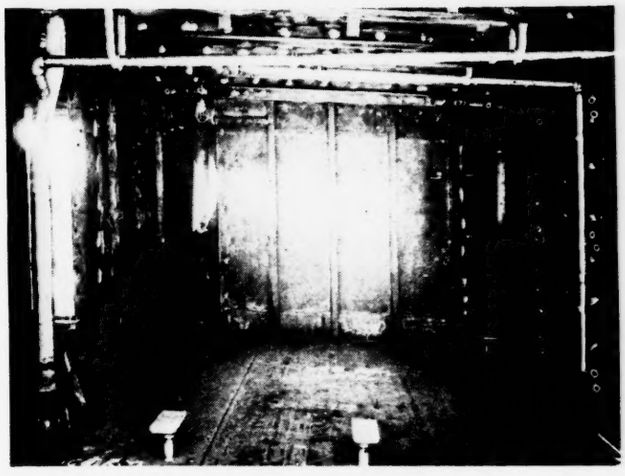


Fig. 4. Space on main deck before installation of cold storage room insulation. Refrigerator drain installed.

Shipping, the Coast Guard (formerly the Bureau of Marine Inspection and Navigation), the American Institute of Electrical Engineers, the U. S. Maritime Commission, and U. S. Senate Report 184 of the 75th Congress (First Session). Most of the regulations are primarily concerned with the testing of equipment and the requirements for spare parts. Senate Report 184, dealing with the safety of ships, covers insulating materials and also requires that each refrigerating system be provided with an emergency overboard discharge connection.

Compressors and Pumps.—The refrigerating machinery for the C-1 vessels built by Consolidated Steel is all of the Freon-12 type. The compressors are vertical, air-cooled, multi-cylinder, single-acting, marine-type with refrigerant suction return entering the cylinders direct. Lubrication is splash on smaller sizes, but usually forced feed is used on the larger sized compressors. Compressor drive is through V-belts with grooved flywheel and motor pulley. Sub-base for compressor and motor is cast iron or structural steel. Compressors are complete with scale trap, suction and discharge stop valves, safety relief valve, automatic controls, and accessories.

Compressors are suitable for operation when there is a momentary roll of the vessel of 20° or a permanent list of 15° to either side, and a permanent inclination of 5° fore and aft. Since a ship rolls three or four times as often as it pitches, all rotating machinery is installed with shaft axes fore and aft wherever possible, to minimize bearing wear caused by gyroscopic action. For ships stores refrigeration, compressor capacity is based on about —5F suction temperature with approximately 21,750 cubic inches displacement and 2.5 brake horsepower per ton of refrigeration. For ships cargo refrigeration, suction temperatures are about as listed in Table 2 with displacement per ton increasing to about 31,100 cubic inches and brake horsepower to about 3.2 at —15F suction temperature. The condensing temperature at which compressors and condensers are rated is 105F with 88F sea water for condensing. The sea water is circulated through the condenser at a rate of 5 gpm per ton refrigeration.

TABLE 3.—THICKNESS OF INSULATION

Compartment Temperature—F	Insulation Thickness, In.
0	10
15	8
30	6
45 to 55	4

Condenser water is supplied by a separate condenser circulating pump with standby service also provided from the ship's flushing or fire main. Automatic water regulator valves are provided to control the amount of cooling water to the condensers, and the pump controls are usually interlocked with the compressor controls so that both units operate simultaneously. Condenser pumps are single-stage centrifugal type of all-bronze construction to withstand the ravages of salt water operation.

Motors and Starters.—Electric power on C-1 vessels is 230 volts D.C., and all motors for refrigerating equipment are direct current designed especially for marine service. Compressor motors are either compound or shunt stabilized (light compounded) type. Pump, fan and miscellaneous motors are usually shunt wound. Motors are drip-proof, ball-bearing, and are provided with rat-proof guards on openings. For engine room and other hot locations, motors are rated at 40C (104F) temperature rise above a 50C (122F) ambient temperature. For above deck and other cool locations, motors are rated at 50C (122F) temperature rise above a 40C (104F) ambient. Installed compressor horsepower per ton refrigeration runs from 3 to 4, depending upon the suction temperature.

Motor starters are drip-proof, magnetic, marine-type with overload and undervoltage protection. The compressor and condenser pump motors, when automatic in operation, are provided with starters having special low voltage protection relays, and require

manual resetting to start up after a power failure. This is necessary because of limited generator capacity on shipboard so that all motors will not go on the line simultaneously when power is resumed after a breakdown.

Condensers.—Condensers are horizontal, marine-type, shell and tube construction for operation with 88F sea water with velocity in the water passes not to exceed 7 feet per second. A minimum condensing surface of 15 square feet per ton is provided. Two types of condenser construction have been used as shown in detail in Table 4. The brass shell construction with cupro-nickel tubes and tube sheets is preferred, but the steel shell construction with brass tubes and tube sheets has been approved by the Maritime Commission as an acceptable substitute in view of material shortages during the war emergency.

Receivers.—Freon-12 liquid receivers are black seamless steel pipe, specification S - 18, of welded construction complete with liquid sumps, liquid level indicators or bull's-eyes, and inlet and outlet valves. Liquid outlet line is provided with dehydrator and strainer to prevent moisture, rust and scale from getting into the piping system. The piping is copper tubing with the exception of the evaporator coils in the ice tank, scuttle butt and refrigerated compartments. Receivers must be designed with sufficient storage capacity to take care of refrigerant surges during load changes and defrosting periods. If receivers are too small, the refrigerant will back up into the condenser during such periods, thus reducing the effective condensing surface and causing the compressors to cycle on high head pressure. Systems having large pipe coil evaporators require comparatively large receivers as compared with systems using fan coolers with comparatively small volume in the evaporator coils.

Evaporators.—Direct - expansion Freon-12 coils for refrigerated compartments are constructed of 1 in. or 1¼ in. standard-weight steel pipe, electrically welded into continuous lengths, and galvanized outside only after fabrication. For ships stores, Maritime Commission specifications require a minimum for most compartments of 1 sq ft of pipe surface to each 6.5 cu ft of gross volume. The gross volume is measured inside the compartment from face to face of the insulation. For cargo holds, the specifications usually require 1 lineal ft of 1¼ in. pipe to each 2 cu ft of gross volume. This is equivalent to 1 sq ft of pipe surface to each 4.6 cu ft of gross volume.

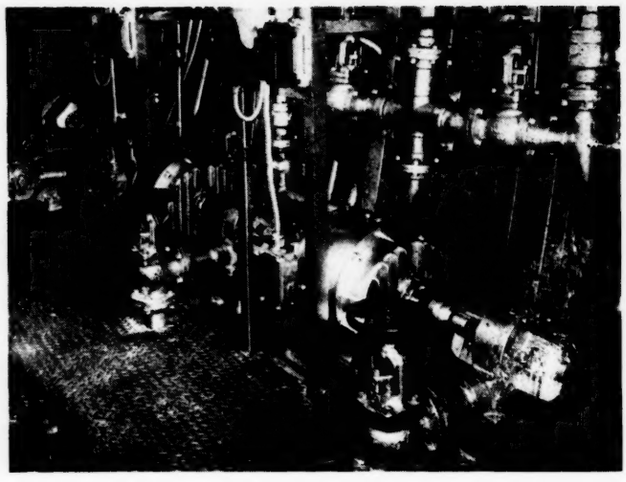


Fig. 5. Part of lower engine room showing the two Westco condenser water pumps with marine-type motors and controls.

Vegetable refrigerators for ships stores are provided with forced air coolers with copper finned cooling coil complete with fan, fan motor, and suction pressure regulator valve. Similar, but larger fan coolers are often specified for cargo refrigeration where temperatures below 25F are not required. In all cases the evaporator coils are of seamless copper tubing with copper fins, tinned after fabrication. Total cooling surface (prime + secondary or finned surface) is required to be approximately 1 sq ft per 6.5 cu ft of gross compartment volume. The fan capacity is such as to provide a 1-minute air change in the compartment, and speed reduction down to 50% is provided. Cargo holds are also provided with facilities for admitting fresh air and expelling foul air. Outside air fan capacity sufficient for 3 changes of fresh air per hour, based on gross compartment volume, is required.

Scuttle Butt (Drinking Water Cooler).—On the C-1 vessels, the scuttle butt has a storage capacity of 40 gallons, and a cooling capacity at the drinking water fountains connected thereto of 5 gallons per hour through a range of 30F. The scuttle butt is a galvanized steel tank completely insulated, and equipped with galvanized outside only steel pipe cooling coil, automatic refrigerant controls, valves and fittings.

Ice Making.—The ice making tank on the C-1 vessels is of special marine design and has a capacity to freeze 150 lb of ice each 24 hours. The complete unit includes galvanized steel brine tank, galvanized

TABLE 4.—CONDENSER CONSTRUCTION

Part	Preferred Construction	Alternate Construction
Shell	Seamless or Welded Brass or Copper	Black Seamless Steel, Spec. S-18
Tubes	⅝ in. O.D. No. 18 Gauge, 70-30 Cupro-nickel	⅝ in. O.C. No. 18 Gauge Admiralty Metal
Tube Sheets	1⅛ in. thick Cupro-nickel	1⅛ in. thick Muntz Metal
Tube Supports	¼ in. thick Brass	¼ in. thick Brass
Water Heads	Heavy cast iron metalayed with red brass and painted with bitumastic paint on water side	Heavy cast iron metalayed with red brass and painted with bitumastic paint on water side

outside only steel pipe cooling coil, three 25 lb galvanized ice cans, corkboard insulation with steel outer casing, automatic controls, valves and connections. The freezing tank is provided with a gasketed cover, and in addition each ice can is provided with a cover, to prevent spilling of brine or water due to rolling or pitching of the vessel. In figuring the refrigeration load for ice making for a small tank of this nature, it is good practice to allow 2 tons of refrigeration capacity per ton of ice making. This figure allows for normal losses and a fairly high temperature of water to the ice cans. The refrigeration load for the 150 lb ice maker would be figured as follows: $\frac{150 \text{ lb ice}}{2{,}000 \text{ lb per ton}} \times 2$ tons refrigeration per ton ice making $= 0.15$ tons refrigeration.

For compressor capacity:

$$\frac{0.15 \text{ tons} \times 24 \text{ hr}}{18 \text{ hr operation}} = 0.20 \text{ tons.}$$

Piping, Controls and Accessories.—Interconnecting piping between the various pieces of refrigerating equipment is of type K seamless, hard-drawn, copper tubing with all joints silver soldered. Fittings are of solder type, either of brass or copper. Tubing is bent wherever possible to eliminate elbows and reduce the number of soldered joints. Freon-12 valves are usually solder-type brass, either packless or else packed and provided with seal caps. Steel valves of the packed type with seal caps and screwed pipe connections are also used. The latter are fitted with brass adapters when soldering to the copper lines. All automatic control valves, dehydrators, etc., are provided with three valve bypasses to permit of continued manual operation when controls are inoperative.

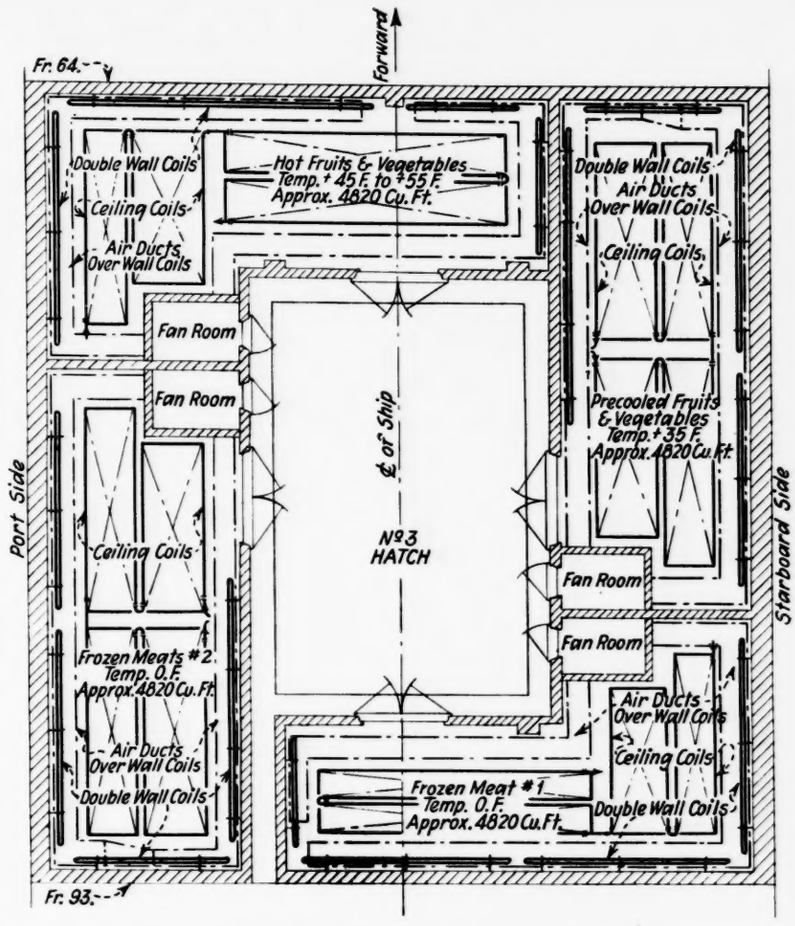

Forward
Fr. 64.
Double Wall Coils
Ceiling Coils
Air Ducts Over Wall Coils
Hot Fruits & Vegetables Temp. +45 F. to +55 F. Approx. 4820 Cu. Ft.
Double Wall Coils
Air Ducts Over Wall Coils
Ceiling Coils
Fan Room
Fan Room
Port Side
℄ of Ship
Precooled Fruits & Vegetables Temp. +35 F. Approx. 4820 Cu. Ft.
Starboard Side
Ceiling Coils
No 3 HATCH
Fan Room
Fan Room
Frozen Meats #2 Temp. 0. F. Approx. 4820 Cu. Ft.
Air Ducts Over Wall Coils
Air Ducts Over Wall Coils
Ceiling Coils
Air Ducts Over Wall Coils
Frozen Meat #1 Temp. 0. F. Approx. 4820 Cu. Ft.
Double Wall Coils
Fr. 93.

Fig. 6. Cargo refrigeration at third deck level.

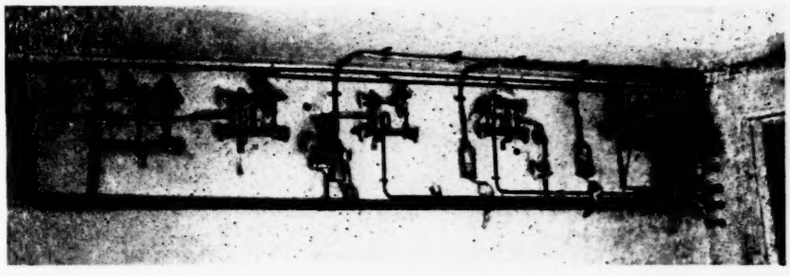


Fig. 7. Forward bulkhead in vegetable compartment showing expansion valve assemblies and thermostats; suction pressure regulator assembly for vegetable room.

Automatic controls consist essentially of high and low pressure cutout switches for the compressors, water regulator valve for the condensers, suction pressure regulators for fan coolers, thermostats and liquid line solenoid valves for each evaporator, and thermal expansion valve or valves (with hand expansion valve in bypass) for each evaporator coil. Thermometers are provided in the inlet and outlet water lines at the condenser. Also mercury-actuated, remote-bulb, dial thermometers are provided for each ships stores compartment. For cargo holds, electric resistance thermometers are provided with remote bulbs in each compartment. High pressure and low pressure Freon-12 gauges, with pressure and temperature scales, are provided for each compressor.

Instructions.—Complete operating manuals, at least two per vessel, are provided covering the proper care and maintenance of the refrigerating equipment. These instructions include cuts of all machinery and controls, spare parts lists, schematic piping and control diagrams, and general layout drawings for carrying aboard ship at all times.

Spares.—Where a number of identical refrigerating units are used, as with ships cargo refrigeration, one extra unit including compressor, condenser and receiver is provided as a spare. The spare unit is interconnected with the piping of the other units so

that it can be used on any system in case of a breakdown. For ships stores refrigeration, where only one compressor is used, a complete set of spare parts for the compressor is provided. In addition, numerous other spare parts and tools are also carried on each vessel.

Equipment for Ships Stores Refrigeration.—The refrigeration equipment for ships stores on each of the C-1 vessels built by Consolidated Steel includes wall coils for all cold storage compartments, except the vegetable compartment which is provided with a York fan cooler (See Table 1 and Figure 6.). Ice making and water cooling facilities include a 150-lb bulk ice maker having 60 lineal feet of 1 in. cooling coil, and a 40-gallon scuttle butt having 43 lineal feet of 1 in. cooling coil. A 5-hp York marine-type Freon-12 condensing unit, complete with condenser and receiver, provides the refrigerating effect. This unit is rated at 1.5 tons refrigeration with —5F suction temperature and 105F for condensing.

Equipment for Ships Cargo Refrigeration.—The four C-1 vessels built by Consolidated Steel with refrigerated cargo space (See Table 2 and Figure 9.) were equipped with 1¼ in. pipe coils on walls and ceilings. Each cargo hold was divided into 4 separate compartments, and the pipe coils in each compartment were divided into 3 circuits each with separate thermal expansion valves (about 800 ft of 1¼ in. pipe per expansion valve). Each compartment was also provided with a recirculating and a fresh air fan. Sheet metal ducts were provided around each compartment so that the recirculated air could be blown down over the wall coils only.

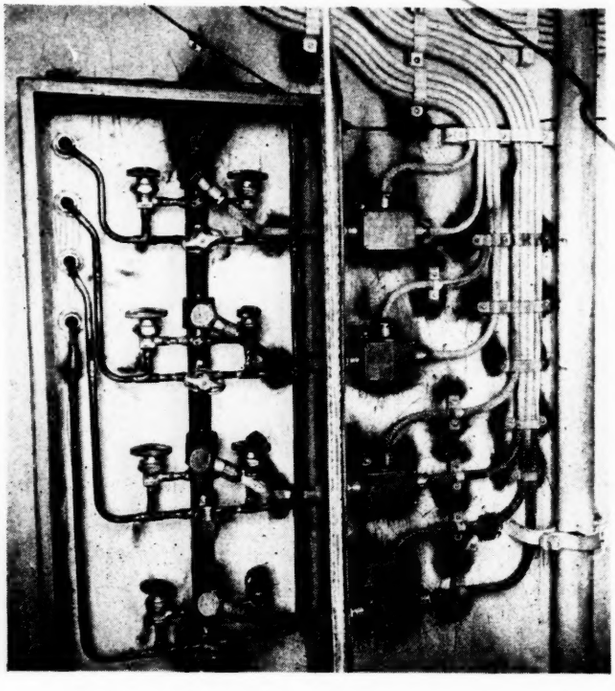


Fig. 8. Bulkhead at inside passageway adjacent to refrigerated compartments showing solenoid valve assemblies and electric wiring.

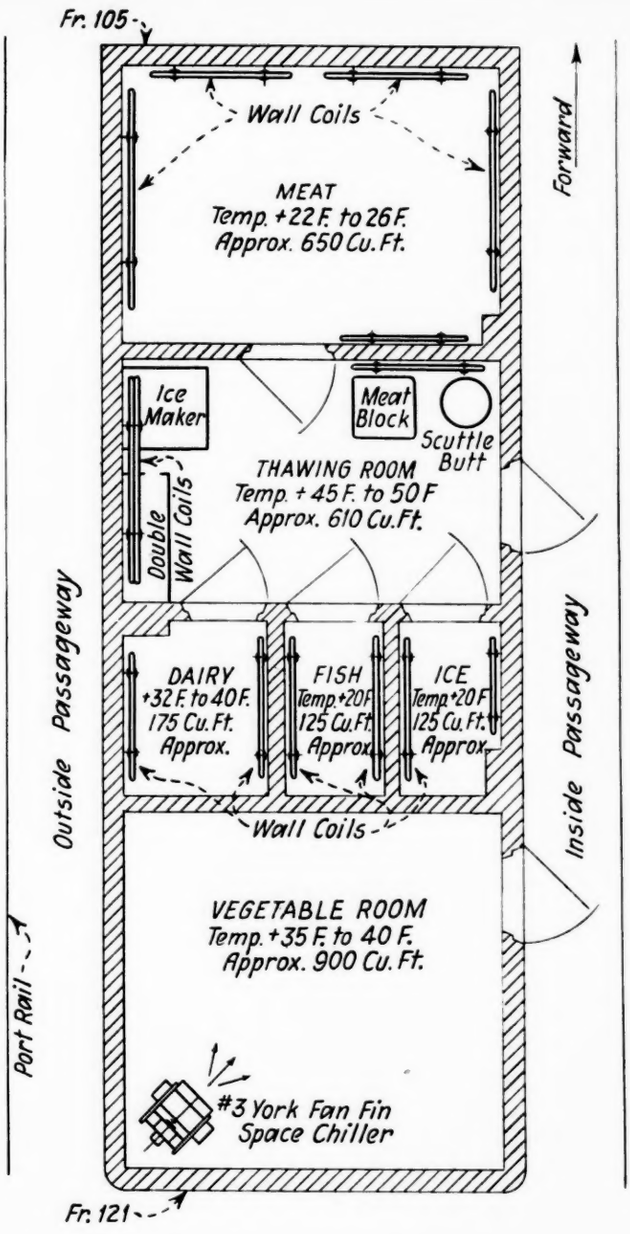


Fig. 9. Ships store refrigeration at main deck level.

Wooden baffles were installed in front of the wall coils to form a passage for the circulated air and to further act as cargo battens. When carrying frozen cargo, all the coils and the recirculating fans are used. When carrying cargo at temperatures above freezing, the ceiling coils are shut off. The fresh air fans are normally used with high temperature cargo, but are shut off when cargo is held at very low temperatures. All compartments were provided with hot gas defrosting.

Each of the four refrigerated compartments was provided with a 10-hp York marine-type Freon-12 condensing unit, complete with condenser and receiver. A fifth condensing unit of identical size and capacity was provided as a spare. Each condensing unit had a capacity of 2.1 tons refrigeration at —15F suction temperature and 105F for condensing.

Wood as a Fuel for Conservation

By T. W. REYNOLDS

The accompanying article, published in the interest of fuel conservation, is reminiscent of the days of Washington, the spinning wheel and the candle, when coal was a novelty and oil was used as a cure for rheumatism. However, today each couple of tons of hardwood burned will save the transportation of a ton of coal which, when burned in industry, will produce about one ton of steel in a warship or tank. Approximately one-third of the total railroad traffic is taken up in the transportation of coal—transportation vitally needed for troops and war materials—and there is no available steel left for the building of additional locomotives and coal cars.

THE writer, possessing a plentiful source of wood and as much energy and curiosity, together with a substantial shortage of oil, burned wood in his round oil-burning steam boiler for two months last fall and learned some things about wood fuel from experience and subsequent research as to the efforts of others.

Critical materials required for the change-over were few—merely three discarded grate bars from a dump. These were cemented at the ends to hold stationary on top of the refractories, and the job was then completed by the removal of a couple of refractories from in front of the ash-pit door. Somewhat later it was found that still better results could be obtained by eliminating the grate bars altogether, building the fire on the ash-pit floor and admitting the air only through the damper on the firing door. This method gave more storage capacity as well as more combustion space, a particular requirement with wood, and particularly so with green wood. It also gave more burning space, thus preventing the long flame and the intense heat from the wood from being wasted through the smoke pipe; thus the wood then did not need to be piled so high. Obviously there are still other advantages, such as obtaining radiant heat from the refractories, and the maintenance of higher ignition temperatures because of the refractories.

More Burning Space Required

If desired, the ash-pit floor of a boiler can easily be covered with a loosely laid temporary layer of firebrick, and if the boiler was formerly fired with coal the ash-pit enclosure may also be protected by firebrick. For the same heat effect as coal, wood requires approximately two-thirds more of burning space and one-third more of grate surface, so that a larger stove, boiler or furnace would be required at maximum load, except that at such times heat requirements can be met, either by maintaining a hotter fire and higher stack temperature, by mixing with the wood an amount of coal or coke as required†, or by the maintenance of the fire on the ash-pit floor.

The real problem with wood is to hold down the rate of combustion which is high because the wood fuel offers very little resistance to the passage of air and the draft is also increased due to the higher stack temperature, particularly so with dry wood;

†Approximately 60% with dry wood, 70% with green wood, depending on how well the wood is seasoned.

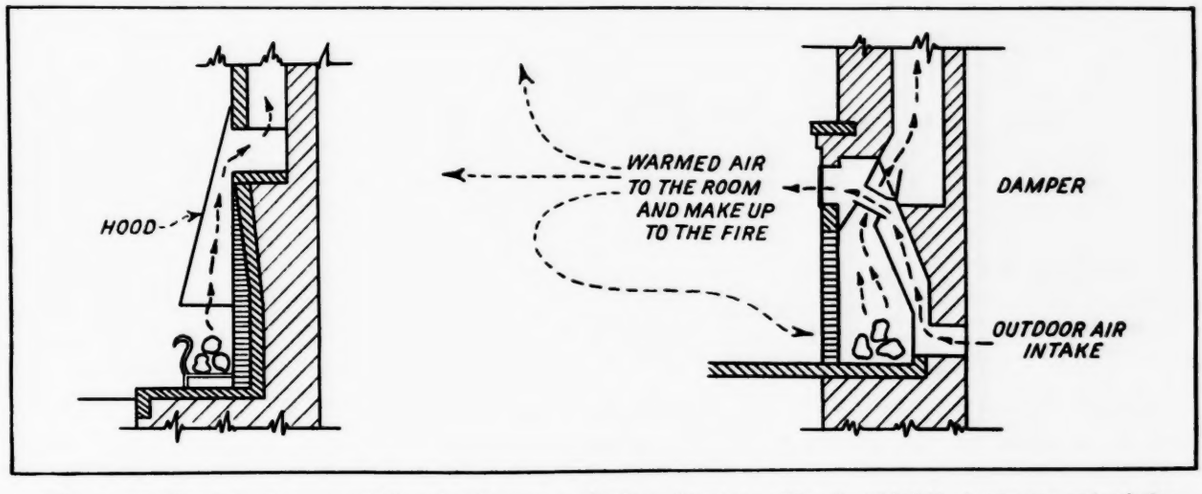


Fig. 1. (Left) A heat transmitting hood over a shallow fireplace. Fig. 2. (Right) Arrangement of fireplace to take outdoor air for room heating and provide makeup air to fire.

therefore, to avoid fuel waste and frequent attention to fire, the smoke-pipe check damper must be closed to about the point where smoke backs out the firing door, while only about twenty per cent of the air should be admitted through the ash-pit door, the balance through slots in the firing door. This holds down the rate at which combustible gases are released, and also admits enough oxygen over the fire to consume the high gas content released from the wood before the gases escape out of the chimney.

Some people can quickly make a dub out of any fire. You have to burn wood for some time and be observant before you can really make a quick fire, a good fire, and a lasting one. Holding a fire, particularly overnight, requires more fuel, large pieces of heaviest hardwood such as oak, and a good throttling of draft dampers. When a hot fire is desired the sticks should be closely spaced so that the heat radiated from each piece helps in driving off the moisture. Because the air spaces in coal grates are more than required with wood, and also because there is less ash than with coal, it is necessary to restrict the amount of grate openings by allowing ashes to accumulate on the grates or by covering over about 60% of the grate with sheet metal, perforated if desired.

Moisture in wood must, of course, be raised to the boiling point, evaporated and then superheated to the flue gas temperature, and therefore serves no useful purpose. The amount of moisture in wood is from 15 to 20% for dry wood, and usually from 25 to 45% for green wood, though in cottonwood or willow it may even be as high as 60 per cent. Seasoning of wood is then desirable. For example, a cord of shagbark hickory weighs 800 lb more than when air dried and this additional weight, mainly one of moisture, reduces the heat value, in this case about one-sixth. On the other hand, there are some woods such as gray birch and aspen which burn too rapidly when well seasoned.

Causes of Creosote Deposits

Acetic and pyroligneous acid given off by slowly burning wood combines with water or moisture to form creosote. A strong draft and a hot fire will carry this out of the chimney outlet, but a chimney in an outside wall (particularly so if well exposed or in a cold climate) will condense the vapors into creosote before the vapors escape, though not necessarily so if the chimney is well lined and constructed with a minimum of two bricks in thickness.

To prevent creosote deposits, green wood should not be used for starting a fire or for a slow fire, a small hot fire being better than a large fire which smolders. Hot water boilers with water temperatures below 160F also cause creosote to form and such boilers must therefore be frequently cleaned. Insulating a smoke pipe will help in reducing creosote formations and thereby prolong the life of the smoke-pipe. Softwoods containing considerable amounts of pitch, smoke to the extent that heavy deposits of soot are formed in the chimney, though such woods do no harm when burned in a fireplace, and are excellent for such use as they quickly ignite and burn like a strong oil burner flame. Soot is also formed by insufficient air or dry air not properly mixed with the gases.

Quick Seasoning of Wood

A fire of dry wood is much easier to kindle and regulate than one of green wood, therefore some seasoning is preferable to none at all. In three

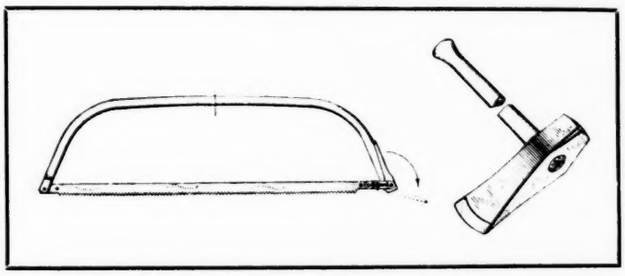


Fig. 3. New-type saw, convenient and speedy for felling trees and a splitting maul for splitting cordwood and driving wedges.

months of fairly dry weather, seasoning from newly cut green wood will be 50% complete (with a heat value equal to 90% of fully seasoned wood), providing that the sticks are separated by criss-crossing for free air circulation. Full seasoning may take anywhere from 6 to 12 months, depending upon the amount of moisture originally in the kind of wood in question and how much there is of humidity in the surrounding air and the exposure to sun, winds, rain, snow and deposits of falling leaves. The wood should not rest directly upon the ground, top pieces should be closely spaced and slanted to shed rain, or otherwise covered over to prevent the passage of rain to wood below. Drying is also accelerated by splitting of the pieces, and by leaving new cut trees to lie where they are for a few weeks in summer during which time moisture will be drawn from the trees by way of the leaves. Some kinds of trees contain so little moisture that not much in the way of drying is necessary; for example, such trees as ash (except for black ash), beech, hickory (pignut and shagbark), black locust and spruce.

Heat Value of Wood

About two pounds of most woods (when thoroughly air-dried) have the same heat value as one pound of coal, particularly so for the hardwoods. Woods containing oils or resins (usually 15%) as in long-leaf pine increase the heat value as the resin itself has double the heat value of wood, and the bark of birch, Douglas fir, shagbark hickory and Ponderosa pine has a heat value greater than that of the wood, but the bark of cedars has very little heat value, as it is high in ash residue.

Oily and resinous woods and most softwoods are

TABLE 1.—EQUIVALENT CORDS OF WOOD PER SHORT TON OF ANTHRACITE†.

(Number of cords required to equal the heat value of a ton of coal. A cord 4x4x8 ft is assumed to contain 80 cu ft of solid wood, with 15 to 20% moisture by actual weight).

1 Cord	1.5 Cords	2 Cords
Hickory	Shortleaf pine	"Cedar"
Oak	Sweetgum (redgum)	Redwood
Beech	Douglas fir	Poplar
Sweet birch	Sycamore	Catalpa
Hard maple	Soft maple	Cypress
Rock elm	Slippery elm	Basswood
Locust	Black cherry	Spruce
Longleaf pine	Tamarack	White pine

†From Farmer's Bulletin 1912, U. S. Department of Agriculture.

consumed rapidly, and therefore because of this and their lower heat value should be used mainly for kindling; whereas oak and hickory burn slowly with a steady heat, and of course the heavier any hardwood is the slower it burns.

Table 1 classifies woods by number of cords required to equal the heat value of one short ton of anthracite; Table 2 lists the approximate weight and heating value per cord of different woods green and dry. It will be noted from the tables that the heat value of wood is more or less proportional to its air dry weight; therefore the most economical kind of wood for the purchaser to buy is usually one with the highest weight per cord. There are some exceptions to this rule, for highly resinous woods have more heat value per ton, and there are other considerations such as price, quickness and uniformity in heating and rapidity and completeness of combustion. Every endeavor should be made to obtain as much volume of wood per cord as possible by specifying sticks unsplit, straight, large in cross-section and short length, as then the sticks can be piled more closely together; further, the wood should be seasoned, as it shrinks about 8% in seasoning.

Measuring a Cord of Wood

A cord of stacked wood 4x4x8 ft, or otherwise piled so as to occupy a space of 128 cu ft, is assumed to contain 80 cu ft of solid wood, though much depends upon the dimensions and shapes of the sticks and how carefully they are piled.* Actually the solid wood content of a cord may vary from 65 cu ft for small irregular sticks up to 90 cu ft for large straight sticks. In some places wood is sold in lengths of 12, 16, or 24 in. Three runs of 16 in. will contain more wood than one pile of wood in 4 ft lengths; for example, one cord of 4 ft wood when sawed into 16 in. lengths will only occupy a space of 100 cu ft when stacked. This same wood thrown into a wagon for delivery will occupy about 160 cu ft and in some localities wood is delivered in a wagon of such size as is presumed to contain an amount of split wood equal to the solid wood cord content of the wood before splitting. In still other places wood may be sold by the basket in an amount equal to a heaped bushel, or by a basket dimensioned as prescribed by law for the particular state in question.

*For example, round wood of small diameter has less of solid wood than split wood of equal length.

Fuel wood is usually classified as hardwood or softwood, green, partly seasoned, or well seasoned, or as mill ends. The last mentioned wood is a softwood used for kindling and sold by the truckload, as it cannot, of course, be stacked for cords. Hardwoods, as most people know, come from broad leaved trees, and softwoods from trees with needle-like leaves.

The State of Connecticut specifies three classes of wood with two grades each, all to be clean, straight, uniform in size, free from rot and holes and duly seasoned. Irrespective of grade, specifications for the wood pieces are as follows: Fireplace wood, 4 to 8 in. diameter with over 5 in. split; furnace wood, 4 to 8 in. diameter with over 8 in. diameter split; and range wood, 2 to 4 in. diameter with over 4 in. split.

Fireplace Wood

Woods such as chestnut, butternut, tamarack, spruce and hemlock are not desirable for use in fireplaces due to snapping and throwing off of sparks. Other woods, black oak and elm for example, contain so much moisture that drying is unequal, so that they hiss with the discharge of steam, and do not burn very well or give off much of heat.

A shallow fireplace throws out more heat than a deep one for the same amount of fire, but a deep fire contains a larger fire and bigger wood; furthermore, the larger pieces of wood burn much longer, require less labor and contain more of solid wood content per cord.

A fireplace is the cause of about five times as much air as is required by good ventilation, provides only about one-third as much heating as an ordinary stove, and takes about ten times as much wood as required by the stove. A fireplace may be altered so that cold infiltrations of outdoor air into the various rooms and the passage of such air over occupants as the air is drawn to the fireplace, will be prevented

TABLE 2.—APPROXIMATE WEIGHT AND HEATING VALUE PER CORD OF WOOD*

Species	Weight, Lb.		Available Heat, Million Btu	
	Green	Air-Dry	Green	Air-Dry
Ash	3,840	3,440	16.5	20.0
Aspen	3,440	2,160	10.3	12.5
Beech, American	4,320	3,760	17.3	21.8
Birch, yellow	4,560	3,680	17.3	21.3
Elm, American	4,320	2,960	14.3	17.2
Hickory, shagbark	5,040	4,240	20.7	24.6
Maple, red	4,000	3,200	15.0	18.6
Maple, sugar	4,480	3,680	18.4	21.3
Oak, red	5,120	3,680	17.9	21.3
Oak, white	5,040	3,920	19.2	22.7
Pine, eastern white	2,880	2,080	12.1	13.3

*From data of the Forest Products Laboratory. In this table a cord is 80 cu ft of solid wood; air-dry means with 20% moisture in terms of oven-dry weight, or 16.7% in terms of total air-dry weight.

by admitting such make-up air directly from outdoors from the rear of the fireplace to a sheet metal duct discharging the air as heated to the room, somewhat as shown in the sketch, Fig. 2. Such a flue may even be extended to a second-floor fireplace and the air delivery of the duct increased due to the greater draft head.

The incoming air is in this way sometimes heated well above 200F and enough so to provide the equivalent of a 30 sq ft steam radiator, or enough to heat a room having a volume of 2700 cu ft when outdoor temperatures are down close to freezing. Ducts may even be extended so as to heat an adjoining room, or a bed-room directly above the fireplace room, particularly so if a fan is used so as to increase both the amount of heat and the positiveness of the air flow. A second-floor fireplace if used should be somewhat smaller than one on the first floor, due to the lesser height of flue.

Still another method of getting more heat from a fireplace out into the room, rather than up the flue, is shown in Fig. 1, wherein a copper hood transmits heat to the room from the shallow fireplace. Incidental to this thought, any fireplace with a large amount of masonry sufrace showing to the room will provide quite some panel heating effect to the room, once the fire has been maintained for say four or five hours, and will continue to transmit the heat to the room as stored up in the masonry for many hours after the fire has gone out. The heat transmitted from the masonry front is radiant and convected heat serving to heat the room rather than the flue. It is often the main source of heat from the fireplace due to the fact that the fine mesh of a good sparkproof fireplace screen intercepts the radiant heat rays from the fire as they strike the screen at various angles, and as a consequence but little of the heat rays find their way through the mesh to the room.

When a fire is out to the extent that only hot ashes remain and it no longer smokes, the fireplace damper may be closed so that none of the heat from the hot ashes and brick lining or from the room is wasted up the flue, but instead is given up to the room.

Selection of Wood

One cord of hardwood can be cut, split and stacked in one day by a good ax man, but it will take three days for the beginner to do the same work. The lone ax man will find the saw and splitting maul shown in Fig. 3 most useful for felling and cutting of trees up to 10 inches in diameter. The frame of the saw is hollow and holds the blade under considerable tension. It is a light saw, easy on the hands, one that does not bind or chatter.

Where one has his choice he will select oak, maple and hickory for most heat with least labor, less smoke and longer fire and again for least labor he will fell those trees which are without knots or twisted grain, and only trees in sizes from twelve to twenty inches in diameter. If cottonwood is cut, it should be split while still green, at which time less labor is required.

In the interests of conservation, one should cut poor trees (preferably of hardwood), improve the dense wood-lot by thinning out of the crooked trees as well as the slower growing trees crowded by others. Dead trees, or trees already down, should be first selected, as should also trees injured by fire, diseased or insect infested trees, or those known as trees prone to disease. Obviously, trees that provide shade or a windbreak for the house should not be cut.

Advantages and Disadvantages

Wood has its advantages and disadvantages. It is hard and bulky and particularly heavy when green. Though the heat value of wood is in line with other fuels when burned efficiently in modern equipment, it is rather low in comparison with other fuels for the transportation space required. Hauling by motor truck over 20 miles seldom pays.

Wood readily ignites and at lower temperatures than coal, can be kept burning with less of fire, and can be made to die out quicker than can a coal fire so that overheating can be avoided. Spring and fall, morning and evening, a quick fire of short duration can easily be made and fed, and this use of wood for a short space of time makes it a more efficient fuel than coal continuously burned.

Wood is a good emergency fuel, a clean fuel to handle and to burn. It gives but little ash to handle, and what ash there is has value as a fertilizer. A cord of hardwood will in burning reduce to 60 lb of ash compared to about 250 lb of dusty ash from hard coal.

Mill waste from lumber mills, pulp and paper mills is often used as a fuel by reducing such waste to mere chips and splinters by a machine called a hog, hence the name hogged fuel, and this fuel is burned in combination with sawdust and shavings in mills and power plants with efficiencies as high as 75%. Automatic stoking of sawdust or other wastewood is sometimes combined with pulverized coal and sawdust is also burned in domestic heating furnaces in Maine and throughout the northwesterly part of the United States. Sawdust and wood-waste briquets are the cleanest of all fuels, readily ignite without kindling, contain very little moisture and ash, take but little storage space, have higher heat value per pound than wood, require but little draft, and burn free of smoke.

The Banner Yarn Dyeing Corporation of Brooklyn, N. Y., is now installing in its plant a sawdust stoker or device for feeding sawdust as secured from processing plants in that city. It is estimated that the annual consumption of coal will be reduced from 6666 tons to about one-third of this amount. The stoker, as furnished and installed by Allington & Curtiss Mfg. Co., Saginaw, Mich., requires in all 12 tons of metal. The sawdust will be burnt in suspension.

Hotel's Fuel Conserved by Application of New Air Eliminating Devices

By T. F. J. MOFFETT

THE current fuel emergency which demands fuel economy in all buildings has brought about many heating plant surveys and resulting recommendations to point the way to sound improvements. Such studies often bring about orders for needed equipment or alterations, although in most cases the same remedies might well have been decided upon a long time back. The fact that deficient heating systems exist in so many instances is something for the heating engineer and contractor to think about. In large measure the defects exist because engineers and contractors have overlooked one of their best markets.

In an Eastern city a 12-story hotel having a 200-ft front and a 7-story rear wing is perhaps a fair example of what heating system surveys will turn up. The owners report that during recent years the heating plant was never entirely satisfactory. Under a restricted oil supply and eventually an order to convert to coal, the owners determined to have the installation examined by a qualified engineer. As a result there will be some expenditures this fall for much needed equipment. It is not overstating the case to assert that there will be sufficient fuel economy to pay for all the improvements; it may be fairly claimed for good measure that the plant will render greater satisfaction during the coming heating seasons and will be much easier to operate.

It is axiomatic that trouble-shooting very often results in a solution by providing rather simple remedies. In the case of this hotel it was largely a matter of getting air out of the system and facilitating the drainage of condensation. The change meant removing a long range of old water seals made of simple piping and installing a considerable number of float-controlled drip traps which would be relatively unaffected by varying boiler pressures. Most of the drip traps will have thermostatic vent outlets intended to clear air out of lagging pockets and at the same time the ends of mains and the tops of steam risers will be supplied with quick vent air valves having liberal discharge ports. Careful study was made of the complex basement piping system to observe where extra bleeder connections would serve a good purpose by helping to clear water out of the lines. All bleeder connections are also trapped, for the return piping drains into an open receiver tank having a boiler return pump.

The preliminary work for this heating system alteration required at least three larger blueprints showing the run of steam mains along the basement ceiling, return lines along the basement floor and passages, and a number of elevations to indicate the proposed details of various piping runs and hookups. The original building plans were not available and it was necessary to bring to the job a portable drawing board so as to note down directly the rather labyrinthian particulars of a busy hotel substructure filled with elevator pits, kitchens, laundries, lockers, washrooms, shops, and storage spaces. It was frequently a difficult matter to follow some of the heating mains even though they were revealed in part in some areas. At length, however, an accurate basement plan and a fully coherent steam piping layout was completed, intended to serve the heating contractor as a guide.

The radiators and heating elements in the upper floors had to be examined, of course, and this meant more leg work, a term familiar in newspaper work when investigations are under way, but not always recognized as a necessary part of good heating engineering on many an occasion. The leg work through the upper floors brought out that in some sections the radiators were connected in the old two-pipe style with an angle valve at each low end. For these radiators a Paul air line system had been installed for venting. Some of the air lines had become obstructed, however.

The boiler room for the job is not centrally located. It is in one extreme corner, handy for fuel supply. The run of the steam mains from the two large steam boilers to extreme corners is such that a considerable pressure drop might be expected. That was perhaps the one big reason for keeping the lines well cleared. The steam supply piping may be roughly described as beginning with 8-inch at the boiler header and reducing or branching off to 6-in., 5-in., 4-in., 3-in., 2½-in, and 2-in. The 2-in. line at the ends of some of the mains does not look very well, for many heating contractors would not install less than 2-inch at the end of the mains in even a comparatively small one-family house. However, the alteration did not contemplate any extensive piping changes.

A schedule of the risers shows a total of about 45, usually 2-in. or 2½-in., some of them running twelve stories for one-pipe radiator connections. At least 30 risers will now have ¾-in. quick vent valves at their top. The purpose, of course, is to clear the air out of all distributing lines as speedily as possible, leaving to each radiator air valve the comparatively easy task of venting its own unit. About 26 of the risers will be two-pipe, having a separate companion return line. All the steam risers will be dripped at the

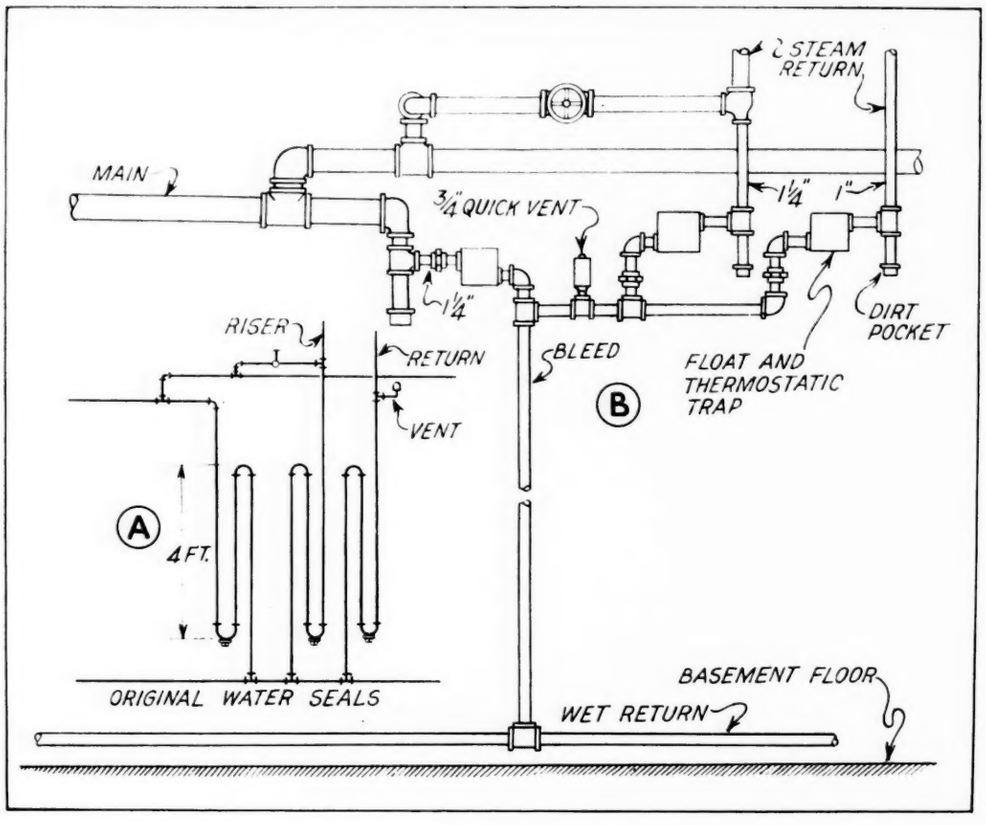


Fig. 1. Diagram (A) shows typical water seals as installed for drip lines. (B) shows method of new traps and vents.

heel, at least 20 of them with 1¼-in. float and thermostatic type traps. All the others will have similar 1-in. drip traps. The return risers will also have 1-in. traps of the same type. A few returns, however, will have regular radiator bellows type return traps, but as a rule these serve only a single main floor radiator.

Alteration work throughout the installation is largely a repetition of the typical details in Fig. 1. The system previously made use of ordinary water seals for drip connections and traps as outlined in Fig. 1-A. The seals generally were about four feet deep, for a pressure resistance of less than two pounds. It was not easy to regulate boiler pressure as precisely as that, or higher pressure was required at times and the seals were frequently blown. That may not have meant much in some sections of the system, for connections to a wet return were often a seal by themselves. But the return in the system is not always wet. In some sections it is a dry return. In some sections it was once dry, but house engineers made some extensions or alterations and the line became wet. In others it may have been wet originally, and later was made dry. In all probability, too, the water seal pockets were not regularly cleaned out. At any rate, the system became sluggish and noisy. It was slow to heat up, wasteful of fuel and unsatisfactory in heating distant sections. Moreover, steam sometimes worked its way into return main and affected return pump operation.

The manner of installing float and thermostatic drip traps as in Fig. 1-B follows the blueprints prepared by Field Engineer John A. Shesler, of Hoffman Specialty Co., Inc. Mr. Shesler surveyed the job and planned the corrections. Where there is no open dry return line for such groups of traps, a quick vent air outlet is included and comes with a ¾-in. discharge port. The discharge port is larger than usual for such vent valves and its purpose should be obvious. The special aim is to clear out all air speedily. There are no water line troubles in connections such as these where the wet return does not go back directly to the boilers. Thus the air vent does not need to be of a float type, but it has a float member which will close against surging water if need be. The vent port, moreover, would not be the full ¾-in. size if the steam operating pressure were intended to be over three pounds. For pressures of from three to ten pounds the same vent valve would come with a port of 3/32-in. size. Naturally the full operating steam pressure does not exert itself against these final vent outlets. The steam is really intercepted by the thermostatic air bypass within the float traps. The air bypass keeps the vent outlet open through the trap until steam reaches the thermostatic bellows. The ordinary steam pressure limit for such traps is 15 lb gauge.

Drawings for the job show that about ten bleeders with traps will be connected to the steam mains in the basement at various locations. About one-half of them will be 1¼-in. size and the others 1-in. There are a number of scattered radiators on the first floor of the building and eighteen of these now have regular radiator return traps. On the upper floors the old air line valves on the two-pipe radiators have been replaced with regular air valves, and practically all the one-pipe radiators and convectors will have similar replacements.

The manner of installing drip traps or vents in an old steam system such as this may be largely a matter of improvization rather than any standard arrangement. A few layouts from the blueprints are shown in Fig. 2. In Fig. 2-A the branch from the main drops under the line and runs over to its riser location. This is an extremely helpful method in some tight quarters where the main is close to the ceiling. It is perfectly feasible as long as the piping pocket is dripped, and it is suitable if a branch con-

nection to a nearby radiator is required from the same line. Then at the end of a line there is no reason why a bleeder trap should not serve also as the drip outlet of a riser.

The return line may be a high one as in Fig. 2-B, and the only requirement is sufficient head for gravity drainage of the condensation. A representative group of connections as outlined in the drawings is shown in Fig. 2-C. The steam main M has a jump-up section and two bleeders, B. The steam and return risers S and R have well sized dirt pockets P at the bottom and the same float and thermostatic type traps, T. The dirt pockets are carefully included in lieu of the usual strainers, taking into consideration the critical shortage of metals. One of the branches feeds two radiators, however, and these have regular radiator return traps, Victory models, rather than the float type. The radiator traps are also marked T. Two ¾-in. quick vent air outlets are included as a V. These clear the air from main, return risers and radiators, also from the bottom of the steam risers.

Fig. 2-D reproduces another part of the drawings. It gives a side view of typical branches from a steam main and back to the return. The single vent valve V will relieve the air from both drip lines, the drip lines taking the condensation away from a steam and a return riser. Similar float type traps are to be used on miscellaneous unit heaters, hot water storage tank coils or any downfeed steam risers.

The developed length of the steam mains and branches in the basement of this building totals well over 2,000 lineal feet. Appropriate control gate valves are placed on main lines and branches. A few minor piping alterations were made at the header of the steam boilers. It seems that the section of the building diagonally across from the boiler room was insufficiently heated. A 3-in. by-pass line had been installed to the far corner, the line starting at the boiler header. This line meanders along the ceiling through available passageways until it reaches its destination. Along the way it has several set-ups to gain new elevation, with a float trap and bleeder pipe at each handy draining point. A line of this kind is obviously a tip to the visiting engineer as to just what ails the installation. After a full basement piping plan was prepared, the practiced eye could judge from the details of a piping layout just about everything required to correct deficiencies.

So long as some risers and radiators are hundreds of feet farther away from the initial steam supply than others, there will be a time and friction loss gap to overcome. Where the immediate defect appears to be the undersizing of supply lines, it follows that an effort will be made to increase the steam carrying capacity. A logical first step is the use of higher operating pressure; a few ounces may prove to be very beneficial. Existing obstructions should be reduced or eliminated as much as possible, these being system air and any accumulations of water.

Liberal use of vent outlets, particularly at levels just below the steam supply mains, is of outstanding usefulness. Since air trapped in horizontal lines is compressed to a lower stratum while the steam flows above it, and since steam mains usually pitch down in the direction of steam flow, the obstruction of trapped air is of greater degree according to the length of line. In addition to the trapped air there will be also the little stream of condensation. Thus the use of bleeder traps which vent the air in addition and *below* the bottom of the mains is of special merit. They leave the lines clear to work at their full capacity. Next, it helps to speed steam distribution to distant parts and higher floors when the tops of risers are equipped with quick vent valves. The risers will first fill all the way with steam and then distribute about equally to the radiators.

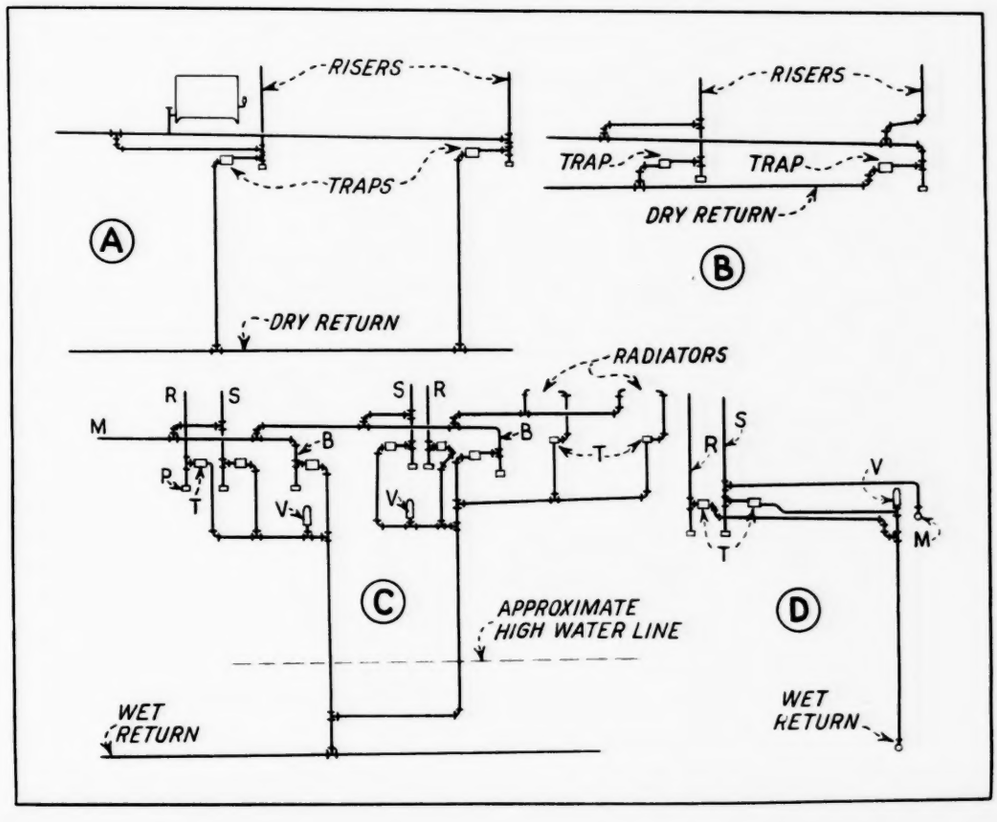


Fig. 2. Some of the many trapping and venting details, taken from the job blueprints.

Westinghouse Electric & Mfg. Co.

installs three air curtains to prevent cold drafts through doorways at its E. Springfield plant.

PROFITS IN AIR
HOW INDUSTRIAL PLANTS PROMOTE PROCESSES BY CONTROL OF AIR CONDITIONS

By R. J. ODABASHIAN

Westinghouse Electric & Manufacturing Company
East Springfield, Mass.

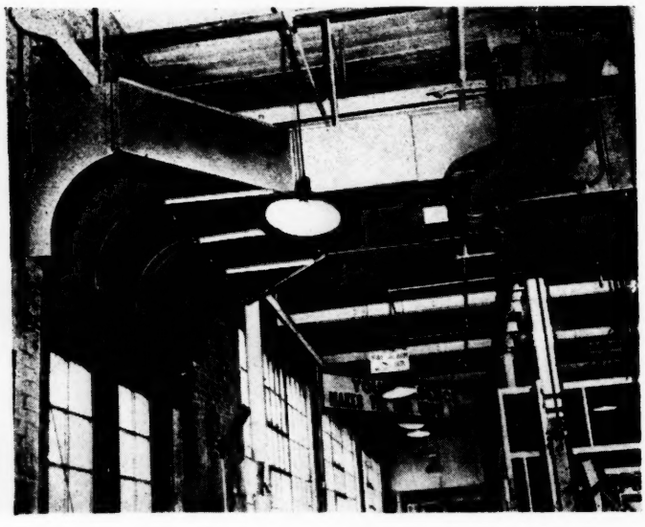
In industrial plants there is always the ever existing problem of eliminating drafts from doors which may be used for loading and unloading or may be general entrances for electric trucks, hand trucks, and pedestrians. During the cold seasons there is that prevalent cry "Close that Door" which may be heard in most every plant.

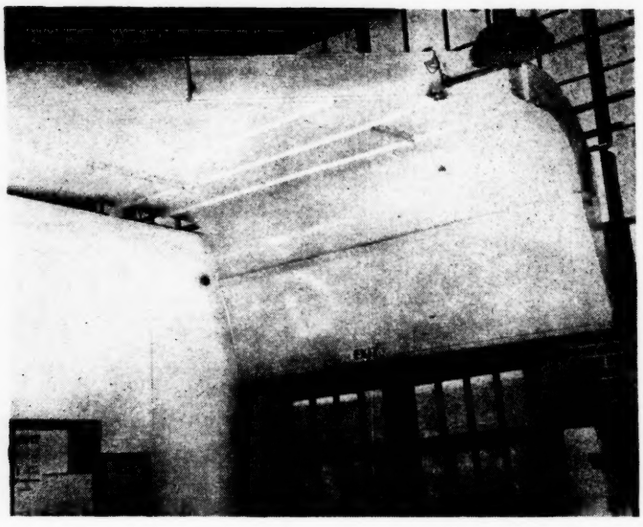
In many cases the elimination of cold blasts through doorways has been solved more or less by the use of vestibules which contain doors at each end of such entrances. There are cases where space limitations do not permit the use of protected entrances and other means have to be provided. At the East Springfield, Mass., plant of the Westinghouse Electric & Manufacturing Company three air curtains have solved this problem.

An air curtain may be defined as a blast of warm air which is spilled past an opening to temper or prevent the passage of cold outside air through the opening. An air curtain to be successful must have a high enough velocity to provide a blanket of warm air over the entire opening. Of course, when a strong cold wind is blowing directly towards a large opening, the only effect of an air curtain, unless an enormous volume of warm air is supplied, is to temper slightly the cold blast.

The installations at this plant consist of commercial steam heating units containing centrifugal fans. The fan outlets are connected to a duct system which terminates over the doorway at a nozzle 3 or 4 in. wide and running the full width of the opening plus about 12 in. overlap at each end. The discharge velocity through the nozzles is approximately 3000 feet per minute. In two of the applications, the heater intake air-supply is from the inside of the building. In the other installation, the heater takes 100% outside air.

Proper temperature control is an essential factor in the successful operation of an air curtain application. The following two methods are typical:





(Left) Air curtain installed in the Die Cast Department. The 8 x 8 ft door is used for electric truck and pedestrian traffic. (Right) Air curtain at a loading and unloading doorway. The opening is 8 x 8 ft.

(1) Where inside air is supplied to the air curtain heater the steam is on the coil at all times during the heating season. The heater fan is started and stopped either by a door switch when the door is opened and closed respectively, or, by a thermostat located near the doorway when the temperature is below or above the control setting, respectively. The main function of the thermostat is to keep the heater fan running after the door is closed until the temperature of the room is brought back to normal. The thermostat also acts to utilize the air curtain heater to augment the heating facilities in the particular section where the heater is located.

(2) Where outside air is supplied to the air curtain heater the heater fan runs continuously to furnish fresh makeup air for the ventilation fans in the building. The steam to the heater is controlled automatically by two thermostats; one is a duct low limit thermostat in the discharge nozzle and the other is a room thermostat located near the doorway. The two thermostats are connected in parallel so that either one may operate the steam valve. The low limit thermostat is set to maintain a minimum temperature of 70F to 75F through the discharge nozzle. With proportioning control the amount of the steam valve opening will depend on the demand.

Air curtains are not a "cure-all" or 100% replacement for vestibules, but they take the curse out of cold blasts where protected entrances cannot be provided because of space or other limitations.

Upjohn Company

employs air conditioning in processing human serum albumin which has one-tenth the bulk of blood plasma.

Human serum albumin differs from dried blood plasma in that it is ready for immediate injection into the patient, whereas dried plasma must be put into solution with distilled water before the transfusion can be made. It differs also in that plasma contains all of the elements of human blood except the red and white cells, while in the case of serum albumin all of the constituents of the blood except the albumin have been removed. The shipping bulk is about one-tenth of that required for an equivalent of plasma. The Upjohn Company, manufacturer of pharmaceuticals, utilizes air conditioning and refrigeration equipment in processing this albumin.

The human blood is received from the Red Cross bleeding centers in ice-cooled shipping containers and is at once stored in a room kept at 34F by means of a Carrier refrigerating machine and cold diffuser. The red and white cells are separated by means of centrifugals, and the clear plasma is siphoned off under aseptic conditions.

Further operations on the plasma are carried out in a room held at 23F by a Carrier air conditioning system. The process consists in precipitating and separating one by one the various constituents of the blood. This is accomplished by controlling three factors, the temperature of the solutions, its hydrogen-ion concentration, and the concentration of the alcohol which is added. In this way the fibrinogen and the various globulin fractions are precipitated and separated and finally the pure albumin is precipitated.

The alcohol is removed by shell-freezing the albumin solution and drying under a high vacuum. The dried albumin is dissolved in sterile water to give a 25% solution. The Carrier equipment serves during this process and is used to cool not only the rooms, but the alcohol solutions, the precipitation mixtures, and the centrifuges.

The finished package of human serum albumin consists of a sterile bottle containing 100 cc. of the solution, fitted with sterilized tubing, needle, and air filter.

McCrosky Tool Corporation

Chills coolant for high speed grinders, saves time, labor, and coolant, prolongs life of machines

A practical and economical method of chilling the coolant oils during high speed surface grinding is being employed by the McCrosky Tool Corporation of Meadville, Pa., manufacturers of machine tools. Chilling the coolant oil to a constant temperature enables continuous operation of the machines for the first time. This application of refrigeration results in saving of time, skilled labor, and war-scarce oil which ofttimes can be re-used, and the life of the machines prolonged.

This refrigerating system, installed by the Apfel Engineering Company, is designed to maintain a constant temperature of sixty degrees during the whole period of grinding. It utilizes a York self-contained cold well water cooler.

Prior to its installation the McCrosky Corporation, which uses two Thompson surface grinders, found that the coolant oil would rise from 80F to approximately 150F within one to two hours, making it necessary to suspend operations.

Fuel Conservation Pointers

By F. H. VALENTINE
Mayer and Valentine
Consulting Engineers, Cleveland.

IN today's fuel emergency it is especially important that every consumer of coal must take full advantage of all heat saving equipment now available whose installation and use would result in substantial coal savings so as to stretch existing available supplies and guard against shortages due to possible further complications in mine labor arrangements and delivery as well as to compensate for loss of production already experienced during the recent interruption in mining. This means that conservation will continue to be necessary and should be initiated while there is still opportunity to do something.

To think about fuel conservation is fine.
To plan to do something about it is better.
To do something about it now is best and what really counts.

Rationing may be necessary, but it seems needless to resort to rationing of coal when a really definite conservation program put into effect would accomplish the same purpose more effectively with less hardship. There is no question that every conscientious owner is concerned about eliminating waste of fuel when he knows its source and a survey of his plant may reveal a considerable number of practices and defects causing waste which might be more or less disregarded in peace time, but which today must be considered wasteful and should be corrected.

Now is the time when men with combustion experience as well as heating experience may be doing a fine service by standing by to give helpful advice to the heating needs of the community. There may be some restrictions on certain critical materials needed but there are no restrictions on individual initiative in giving advice. The public needs this assistance and cooperation to prevent waste and help win the war.

How can we, as individuals, do our bit in this all-important work? We might suggest to fuel users that practices often resulting in fuel waste commonly caused by such conditions as improper firing methods, neglected essential repairs, neglected heat losses and many other items be carefully checked and corrected where correction is necessary. These practices are correctable and the results will not only go a long way towards relieving the present fuel situation and insuring a more adequate supply of fuels for all, but will allow us to preserve our health, enjoy comfortable warmth and in the end prove economical where such wasteful conditions prevail.

The writer offers herewith a few of many practices and conditions often witnessed during his experience which definitely result in fuel waste:

1—Provide enough air for proper combustion in the boiler or furnace room. Coal and other fuels require air to burn and fuels cannot be burned effectively without sufficient air to support combustion. Provide windows or other openings of ample area into the boiler or furnace room and keep them open.

2—Avoid the flow of black smoke from the chimney; smoke is the result of improper firing and incomplete combustion and means waste. Stop smoke by using the coking or alternate method of firing; that is, feed the fresh coal on the front of the fuel bed and when this is fully ignited, push these live coals to the side or rear before firing the next charge. This method permits full combustion of the volatile gases given off by the new coal while passing over the live coal bed and prevents smoke, soot formation, and waste.

3—Use coal that is uniform in size. Mixing of large and small sizes of coal, particularly slack, often causes obstruction to draft in hand-fired plants; also results in waste of unburned coal when cleaning fire. Break up the large lumps of coal when mixing with small size coal and carry as uniform thickness a bed of fuel as possible and still maintain proper draft, keeping the grate covered with a level fire, avoiding dead or bare spots which permit excess air to enter and carry heat units up the chimney.

4—Regulate boiler or furnace draft by use of dampers to reduce excess air and only allow sufficient draft to burn the coal as fast as required to heat the building. Keep firing doors closed as much as possible, controlling the air admitted over the fire through the fire door grille to suit draft necessary to ignite the fresh coal. Excess air is a most expensive material when admitted to burn more fuel than required. It causes a waste of fuel that grows as the amount of excess air increases.

5—Prevent the waste of unburned fuel and coal siftings getting into the ashes by cleaning the fires carefully and by using suitable cleaning and slicing tools. Cinders (unburned coal) and coal siftings are valuable carbon which should not be wasted. Sift out these from the ashes and put back in boiler or furnace where same can be burned.

6—Keep the boiler or furnace passages free from soot; clean tubes and flue passages give higher degree of heat absorption. Soot decreases heat absorption in proportion to its accumulation and

results in waste. Clean at regular and frequent intervals with a good flue brush or other cleaning method.

7—Keep ash pit free of ash accumulation which has a tendency to cut off circulation of air for proper combustion; also if allowed to accumulate too long will cause warping and burning out of grates, necessitating replacement.

8—Avoid excess smoke pipe temperatures; this is heat escaping unchecked up the chimney and a big loss and waste of fuel. To prevent this, install a balanced draft regulator in the smoke pipe between boiler or furnace and the chimney.

9—Examine the boiler or furnace settings carefully for air leakage, particularly furnace door, cracks in side walls, joints between boiler or furnace sections, brick-work and ash pit sections. In a boiler or furnace the completeness of combustion depends largely upon the correct proportioning of fuel and air and upon an intimate mixture of the two. Any air leakage into a boiler or furnace where not intended only serves to dilute the products of combustion, destroys the draft, uses excess fuel to heat it, and lowers efficiency.

10—Do not force boiler or furnace unnecessarily. If it does not furnish sufficient heat to heat the building, investigate the cause and correct it—do not try to make the fuel do the job. Burning fuel in excess of that actually required to meet the heat demand results in hot flue gases escaping to the chimney, which is an avoidable waste of fuel.

11—Keep the internal boiler or furnace surfaces free from scale, dirt or rust accumulations. These are insulators and retard heat transfer and waste fuel trying to keep up with the heat requirements. Sludge, oil, lime, and rust deposits should be removed from interior of boilers (either steam or hot water) by using a good boiler cleaning compound. Remove dirt and rust from a furnace by use of a vacuum cleaner.

12—Avoid leakage of steam from boiler and piping system fittings and valves. Steam requires fuel to produce it and any lost where it is not effecting heat transfer is a waste of fuel. Keep in proper operating condition all air vents, traps, controls, and other important items of a heating plant. Prompt correction of these troubles usually requires little time and the outlay of relatively small sums of money which will be repaid many times over in fuel saved as well as avoidance of major repairs that would otherwise be required later on.

13—Replace missing or damaged boiler or furnace insulation; also insulate uncovered hot water tanks, heat ducts or pipe work to prevent dissipation of heat in places where it is not wanted. Such losses from these sources reflect on the fuel consumption.

14—Prevent overheating and maintain uniform temperatures in all occupied spaces. Overheating is as injurious to health as underheating and it requires excess fuel to produce this overheating condition. Temperatures over 70F are actually dangerous to health to persons other than infants and invalids. Thermostatic control is the most effective method of controlling temperatures and it not only insures better health but saves fuel.

15—Provide proper humidity control. Dry air feels cooler at the same temperature than does air which is properly humidified, hence requires excess heating to be comfortable.

16—Install storm windows and doors, also weatherstrip and caulk unnecessary openings around windows and doors. Cracks admit cold air, requiring excess fuel consumption to maintain temperatures desired. Also insulate walls, ceilings and attic spaces against heat loss by conduction.

17—Keep radiators of a steam or hot water heating system clear of covers, drapes, top shields and other objects which retard circulation of room air over the surfaces of these radiators. If desired, reflecting shields may be installed behind the radiator to increase heat convection. Retarded circulation of air over radiator surfaces results in slow heating and a corresponding loss of fuel to bring up proper room temperature.

18—Where fireplaces exist in a room, keep the fireplace damper closed when no fire is burning. Fireplaces are stacks which remove heat rapidly from the room, causing a direct loss of heat.

A. C. & F. Air Conditions Hospital

In the hospital of the American Car and Foundry Company tank arsenal, Berwick, Pa., modern air conditioning equipment has been installed for the benefit both of patients and hospital attendants. A Carrier self-contained air conditioning unit is located within a closet from which ducts carry the air, and supplies conditioned air to the dispensary, operating room, X-Ray room, dressing room, doctor's office and surgical room.

Dr. R. F. Wear, company physician, believes that the air conditioning installation has proved beneficial in its effect on workers coming to the hospital, and at the same time has increased the efficiency of the hospital staff.

WASHINGTON NEWS

Summarized by Loring F. Overman. In-Process Oil Conversion May Stop; Copper Lack Retards Controls Program; Freon Restrictions May Be Eased.

What a drain the demands of total war can place upon the supply system of a nation that once seemed to have "too much of everything" is being forcibly demonstrated as the second anniversary of Pearl Harbor approaches. Too, it is becoming more and more apparent that efforts to solve some of the problems can be quite tricky.

Perhaps it is impossible, some Washington conferees are concluding, to try to plug a threatening crack in the wall, without being fairly certain that the action will cause breaks somewhere else along the line. At one time, when surpluses existed, giving the military forces the lion's share was the natural answer. Today, however, the effects of some of yesterday's yielding to military necessity is not only pinching civilian economy, but is threatening some of the sources of the items upon which the military forces themselves depend.

Last year, for example, fuel oil was scarce; coal production and reserves were plentiful. Conversion to coal seemed a logical answer. This year, fuel oil stocks are still below normal; thousands of homes and industrial plants have converted heating and power plants to use coal—and a shortage of 15,000,000 tons of coal is in prospect, assuming that no major strike or other work stoppage takes place. (Strike shutdowns last spring reduced expected 1943 production by nearly 25 million tons.)

One regrettable thing about efforts to arrest a trend once it has been noted, is the time lag that must take place between its discovery and its correction. It is true that a special Senate committee is struggling with the problem of the threatened coal shortage; the testimony it is receiving from the experts indicates that 1944 may find the situation even worse than in 1943.

"The basic trouble is clear," members of the Senate committee were told by the Deputy Fuel Administrator Howard A. Gray. "Consumption requirements for solid fuels have reached an all-time high level and are continuing to increase. Production of solid fuels has not increased proportionately. Approximately 665,000,000 tons of coal will be consumed in 1943, while estimated production will total 650,000,000 tons. The difference will have to come from stockpiles."

The necessary quantity is available in stockpiles, members of the Senate committee were told, but since transportation is involved, whether the coal comes from inventories or from mines, there is a possibility that local shortages will develop despite the fact that the overall supply promises to be sufficient.

No Coupon Rationing

Despite the seriousness of the coal situation, Chester Bowles, General Manager of the Office of Price Administration, announced October 23 that there will be no coupon rationing of coal during the coming winter. The statement was made to clarify the coal situation, particularly in the Northeast, where many persons normally using anthracite have been unable to obtain deliveries.

With coupon rationing out of the picture, deliveries are being curtailed so as to spread supplies as evenly as possible. Householders unable to obtain sufficient anthracite to meet their immediate heating needs are urged to supplement hard coal with bituminous coal, Mr. Bowles said. The Solid Fuels Administration's restrictions on deliveries to dealers limit total deliveries to not more than 90% of the domestic anthracite received in the last heating season. The restrictions, applying to the 12 northeastern states and the District of Columbia, direct dealers to supply anthracite first to those having less than 25% of their needs on hand, and prohibit building consumers' stocks to more than 50% of last season's consumption.

Conservation Urged

Supplementing the nationwide critical resources conservation campaign, Secretary of the Interior Harold L. Ickes announced October 8 the launching of a fuel efficiency program to combat wasteful practices in the use of coal, coke, wood, petroleum and gas.

First step in the campaign was the appointment, from private industry, of a National Fuel Efficiency Council of 12 engineers outstanding in the field of fuel utilization to chart and direct the campaign in cooperation with the Bureau of Mines. At its initial meeting in Washington, members of the Council estimated that industrial, commercial and domestic uses annually could save 29 million tons of coal alone by adopting known methods of efficient utilization.

The council will depend primarily upon education and training of industrial consumers to achieve results, through the assistance of subcommittees of engineers to carry out programs at regional and local levels. Hundreds of engineers have already expressed their willingness to cooperate. The assistance of national engineering societies and other organizations also is being sought.

Members of the council are: chairman Thomas C. Cheasley, new supervising engineer of the Bureau's National Fuel Efficiency Section who for the last 13 years has been fuel engineer for the Sinclair Coal Company of Kansas City, Mo.; O. F. Campbell, combustion engineer for the Sinclair Refining Company; W. G. Christy, Jersey City, N. J., smoke abatement engineer for the Hudson County Department of Smoke Regulation; C. F. Hardy, Cincinnati, manager, Fuel Engineering Division, Appalachian Coals, Inc.; H. K. Kugel, Washington, D. C., smoke regulation engineer for the District of Columbia; L. S. Reagan, Tulsa, Okla., vice president, Webster Engineering Company; C. A. Reed, Washington, D. C., director, Engineering Department, National Coal Association; H. J. Rose, Primos, Pa., vice-president in charge of research, Anthracite Industries, Inc.; R. A. Sherman, Columbus, Ohio, supervisor, Fuels Division, Battelle Memorial Institute; A. W. Thorson, Washington, D. C., head conversion engineer, Solid Fuels Administration for War; J. E. Tobey, New York, managing director, Coal Bureau, Upper Monongahela Valley Association; and an exofficio member, J. F. Barkley of Washington, D. C., chief, Division of Solid Fuels Utilization for War, Bureau of Mines.

On October 14, Solid Fuels Administrator Ickes announced the appointment of 62 engineers to serve the SFA without compensation for general consultation and field survey work solely in connection with engineering problems involving utilization of coal. The engineers who have accepted appointment to assist the

Administration remain free to continue their regular occupation. Their services will be available to industrial consumers who desire advice on combustion problems in their plants.

To facilitate contact with other Government agencies, J. E. Tobey, 122 E. 42nd St., New York, has been designated as chief consultant in the New York area and Vernon G. Leach, 231 La Salle St., Chicago, as chief consultant in the Chicago area.

In-Process Conversion May Stop

Industrial fuel - oil consumers throughout the country who are in process of converting burners to substitute fuel may suspend such conversion activities at once, it was announced October 19 by Administrator Ickes. The action primarily affects industrial consumers in the 17 East Coast and 15 Midwestern states, and applies only to users of the heavy, residual type fuel. PAW emphasized that heating oils of the distillate type continue to be short and there should be no relaxation in efforts to conserve that product. There is every prospect that the shortage of home heating oils will continue, because, with the increasing amount of each barrel of crude that must go into petroleum war products, it is not possible to expand materially the volume of distillate.

Three factors responsible for improving the fuel oil situation were named by Administrator Ickes, as follows:

"First, 11,136 plants on the Atlantic Seaboard converted to substitute fuels, effecting an annual saving of approximately 50,934,400 barrels of fuel oil annually, while another 11,339,700 barrels annually were saved by 2,590 conversions in Midwestern states. If these plants had not converted, industrial fuel - oil stocks would still be critically short.

"Second, the remarkable improvement made in transportation during the last two years affords a flexibility in the distribution of available supply which had not been present in the past.

"Third, the proportion of light to heavy products for the military forces has changed to an extent which operates to ease the residual fuel position at this time."

Pipeline Deliveries

Deliveries of crude oil and petroleum products to the East Coast by pipe line reached an all-time high of more than 400,000 barrels a day during the week ended October 16. At the same time the PAW East Coast Petroleum Supply Bulletin revealed that inventories of light heating oil increased at the rate of 150,000 barrels a day despite the opening of the heating season. Increase in pipe line deliveries followed reopening of the New York branch of the "Big Inch" line, after a 52-day shut-down to repair defective pipe.

Tank car deliveries during the same week dropped to 748,823 barrels a day. Many of the tank cars formerly on the run between Norris City, Ill., and the East Coast have been shifted to the longer Texas run, while others are temporarily out of service while being cleaned to transport gasoline and heating oil instead of crude oil.

Heating Controls Program

Sponsors of the program seeking to produce heating controls are beginning to wonder whether all of the obstacles placed in the way of the program are merely natural results of the desire to provide critical metals for military purposes. For months, efforts to have the manufacture of controls authorized were fruitless. Then Limitation Order L-79 was amended to provide that 23 types of controls could be purchased without priority ratings, with fuel conservation as the goal.

The Office of Civilian Requirements finally approved the program and put in a claim for enough materials to build some 700,000 control units. The WPB Requirements Committee expressed a willingness to release everything but copper, and during the closing week of October the program was still stymied. A conference scheduled for October 24 before the WPB Program Adjustment Committee was expected to result in allocation of the necessary materials, although there was still a question regarding copper.

Since copper is again to appear in pennies, some sponsors of the controls program have observed that it may be "penny wise" not to release copper for the manufacture of control units intended to save millions of dollars worth of coal. With the National Fuel Efficiency Council program just getting under way, it may be anticipated that insistence of its members on adequate control mechanisms will be a factor in prying the controls program out of conference.

Freon Order Change Due

Early amendment of Conservation Order M-28, to ease slightly the restrictions placed on delivery of Freon refrigerant to certain classes of users, is expected. The situation is still reported as tight, but completion of a new Freon plant in February is expected to ease the supply situation considerably. The contemplated amendment of Order M-28 will make only minor changes to take care of emergency conditions, it is indicated.

Task committees appointed by WPB General Refrigeration and Air Conditioning and the Industrial Refrigeration Advisory Committees have estimated that civilian requirements for Freon in 1944 will be 11,400,000 pounds, based on existing commercial and industrial refrigeration and air conditioning equipment. To this figure approximately 2,000,000 pounds should be added, the report to WPB stated, to make up for the deficit incurred during the second half of 1943. Civilian requirements for 1945 were estimated at 13,000,000 pounds.

The report of the task committee also estimated requirements for refrigeration equipment. The estimated amount of necessary replacement equipment for 1944 indicates that considerable equipment is being operated beyond its normal life expectancy, and that it will be impossible to make necessary replacements in food processing and storage facilities unless the amount of equipment available in 1943 is greatly augmented next year.

Fire Tube Boilers

Fire-tube steam boilers designed to withstand safe working pressures in excess of 15 pounds per square inch, which are not otherwise included in Table 8 of Order M-293, have been designated Class X products by an amendment to the table, announced October 25. Fire - tube steam boilers have been subject to scheduling under the terms of Order L-117, but this regulation has been revoked, and the boilers will be scheduled under Order M-293.

OPA Committee Named

A Cast Iron Hot Water Supply Boiler Industry Advisory Committee composed of six officials of manufacturing firms was appointed October 20 by the Office of Price Administration. The committee, which will advise OPA and make recommendations concerning pricing problems of the industry, was scheduled to hold its first meeting in Washington, October 28. Appointed to the committee are the following:

David L. Deen, sales manager, Freed Heater and Stoker Co.; George L. Harberger, sales manager, Eastern Foundry Co.; Max D. Rose, vice-president, American Radiator and Standard Sanitary Corp.; F. S. Ross, president, American Boiler and Foundry Co.; Frank Werner, president, Werner Foundry Co.; and E. R. Westphal, plant manager, Weil McLain Co.

How to Design Exhaust Hoods

By J. M. DALLA VALLE
Engineer and Consultant,
Kruse Engineering Co.,
Newark, N. J.

Part 9—Booth-Like Structures for Fumes, Vapors, and Gases

Spray Painting Booths

Effective ventilation of spray painting booths or hoods offers several difficult problems. These problems pertain first to the inability of the operator to control the air flow advantageously (because the objects sprayed often constitute serious barriers) and secondly to the need for devising methods to remove any spray paint which escapes and clogs the exhaust system. To overcome these difficulties, it is essential to spray only such objects as are small in comparison with the opening (less than one-third the area of the opening), and to utilize an ejector-type exhaust system which eliminates any direct contact with the fan blades. Spray paint booths should utilize air velocities of not less than 100 feet per minute at the opening; it is rarely necessary to exceed velocities of 200 feet per minute.

Velocity Distribution at Booth Opening

The velocity distribution in front of an unimpeded opening (similar to a spray paint booth) was shown in Fig. 27. The velocity in the plane of the opening is uniform. Where booths are exhausted by propeller-type fans, considerable turbulence results at the openings when the booths are shallow. A typical set of air velocity distributions, taken from an early publication on spray painting, is shown in Fig. 73. It will be seen that the velocities in the plane of the opening are fairly uniform, although they appear slightly higher to the right of the fan. The contours give no indication of the direction of the flow or the obstructions on either side of the opening, which might explain the asymmetry which is seen to exist. The variation in velocities through a vertical midsection of the booth opening with a panel-type ob-

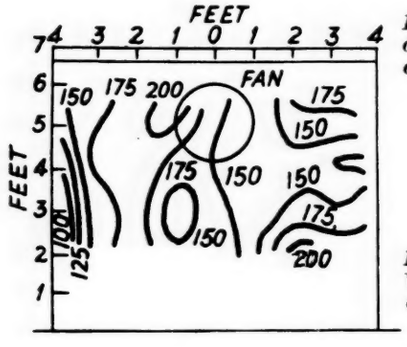


Fig. 73. (Left) Air distribution over opening of spray paint booth.

Fig. 74. (Right) Velocity distribution due to obstruction in booth.

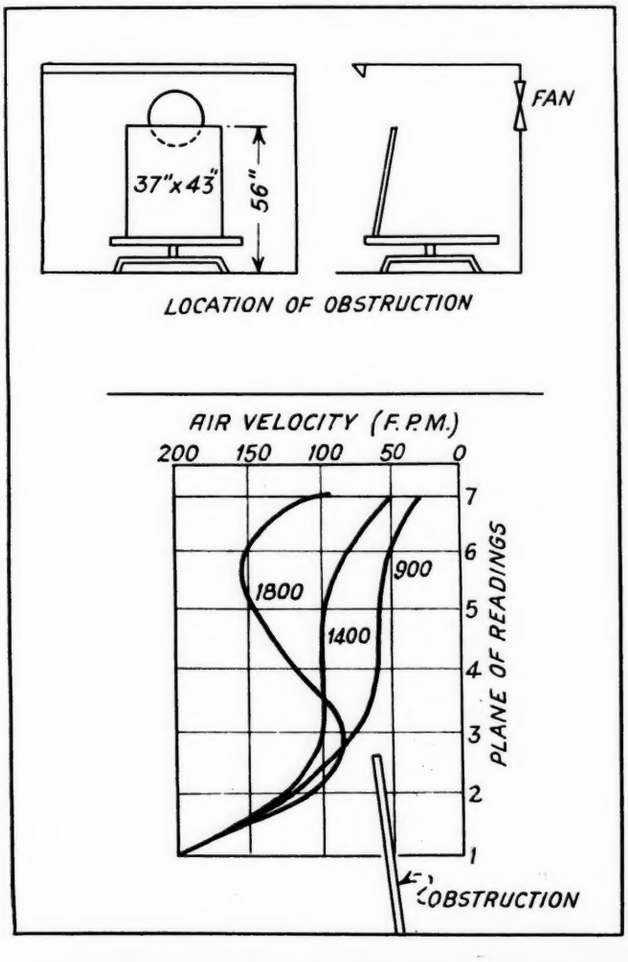
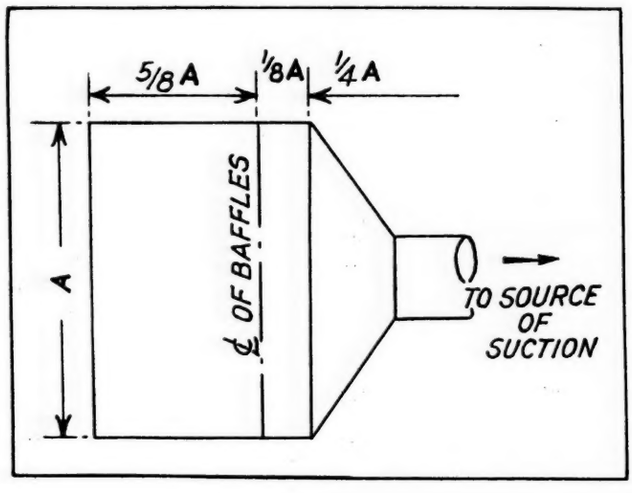


Fig. 75. Dimensional data for small booth.



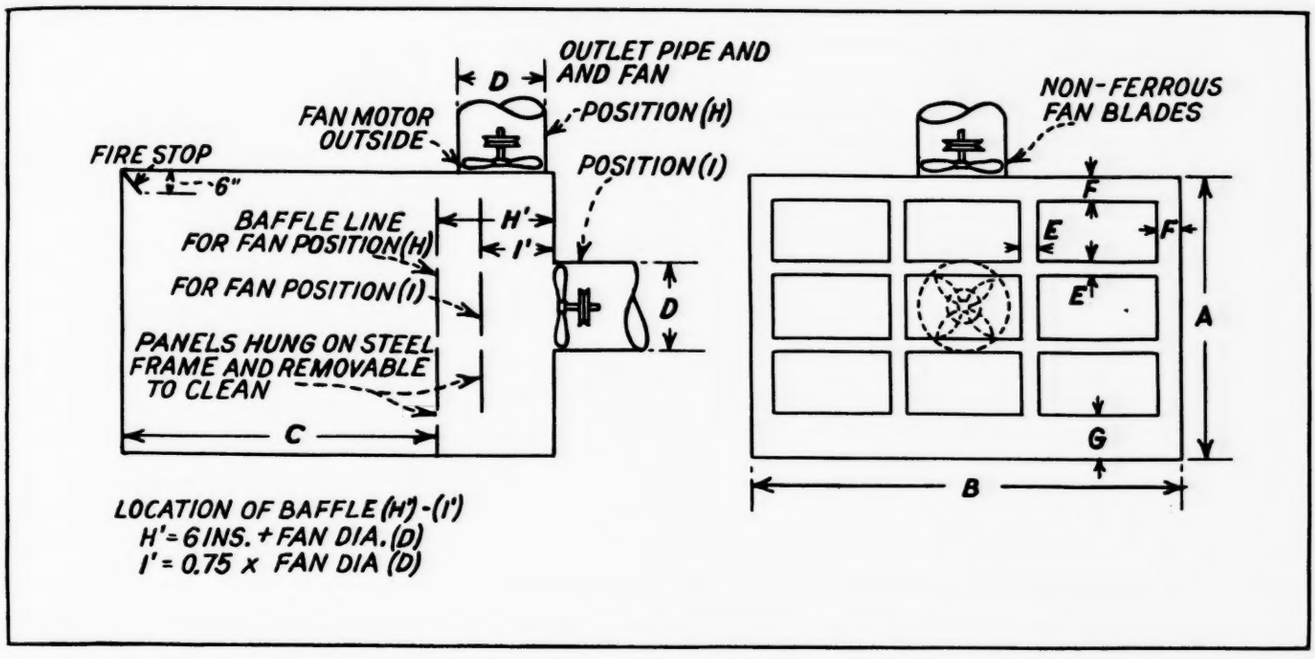
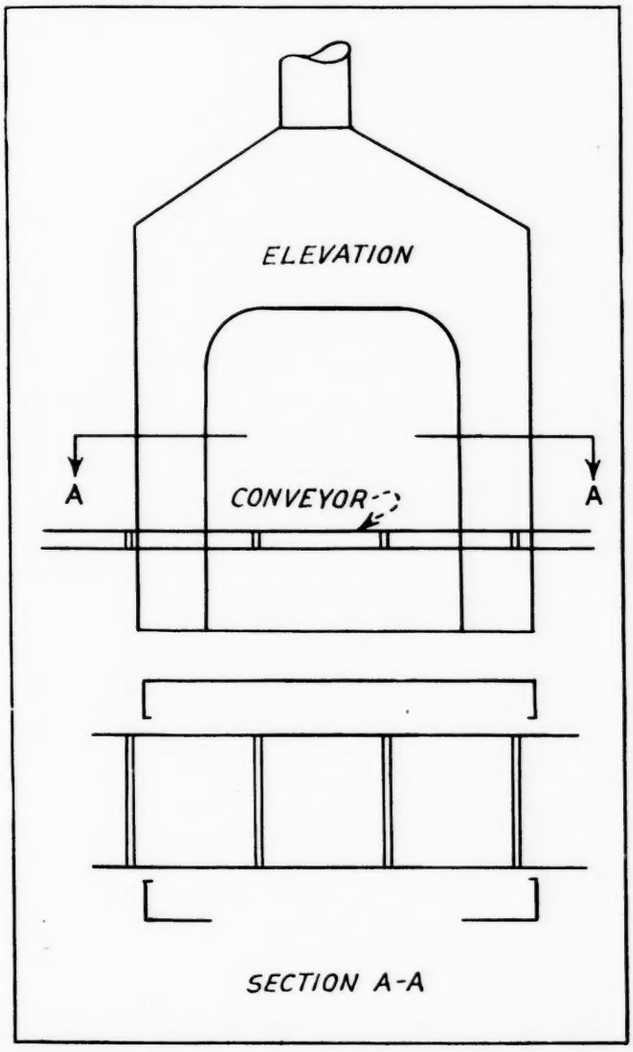


Fig. 76. Suggested baffle arrangement for paint spray booth.

Fig. 77. One type of booth arrangement for mechanical conveyor.



struction is illustrated in Fig. 74. At high fan speeds little change in air velocity takes place at the tip of the obstruction. Hence, higher air velocities do not necessarily mean more effective removal of vapors and mists. Consideration must be given to location of the obstruction, so that it offers a minimum of resistance to the flow of air.

Design of a Stationary Spray Booth

No fixed dimensions can be given for an efficient design of a spray booth. As pointed out, the objects sprayed (as well as the technique of the operator) have considerable bearing upon the effectiveness of a booth. However, most booths follow a more or less fixed pattern which, under proper conditions, has given good results. This is shown in Fig. 75, in which the characteristic dimension is the height of the hood "A." The relationships given in the figure are applicable to square booths and for opening dimensions having a side ratio of one to two. Hoods should not be too shallow, especially if propeller blade fans are used. The transition dimension is intended only for booths using duct exhausts.

Propeller blade fans are not to be recommended because they become laden with spray coatings. Venturi-type exhausts are to be preferred, although any paddle-wheel type of fan is also suitable.

The size of the booth is obviously determined by the dimensions of the object to be sprayed and by the position taken by the operator. If the operator stands outside, the cross-sectional area should be just large enough to accommodate the object, but if it is long and requires the presence of the operator within the booth the space provided should be sufficient to enable proper performance of his work. The design shown in Fig. 75 is not suitable for more than one operator. The operator should be able to reach all parts of the object sprayed without being subject to rebound of spray or the necessity of standing between the gun and the air outlet.

TABLE 18.—SPRAY BOOTH BAFFLE DIMENSIONS

Baffles	Number and Spacing			
Cross-Sectional Dimensions, Ft. (AxB)**	No. of Panels	Spacing, Inches		
		Between Panels (E)	Top and Side (F)	Bottom (G)
3 x 3	1	*	*	*
6½ x 4	3	4	6	12
6½ x 6	4	4	6	12
6½ x 8	6	4	10	12
6½ x 10	9	6	10	18
9 x 12†	9	8	12	18
12 x 14‡	12	8	18	24

*For booths 3 x 3 ft and smaller: 1 panel 6 in. larger than fan diameter.
**For booths of dimensions not shown, use nearest size in table for number and spacing of baffles.
†Pleasure automobile booth.
‡Automobile truck booth.

So as to obtain a uniform flow of air into the booth, baffles should be provided near the outlet end. This is especially necessary for two reasons: (1) Spray booths are usually shallow in depth as compared with the cross-sectional dimensions and the fan inlet is usually abrupt; (2) they tend to collect some of the spray and prevent it from entering the fan. Many designs of baffles are possible, but in general the type shown in Fig. 76 has been found practical. These are simply metal sheets suspended at the points shown in the figure.

The size and spacing of the panels is optional, although the dimensions given in Table 18 for small booth are recommended. These baffles should be removed frequently and cleaned of the accumulated spray. It must always be remembered that spray booths are potential fire hazards and must be free of inflammable material. Some reduction in air turbulence and rebound of spray may be obtained by inserting 6-inch angle baffles along the two sides and top of the spray booth. Such baffles also act as fire stops and are often recommended for this purpose by fire officials.

When lights are inserted for illumination, they should always be of the vapor-proof type. Fans should be constructed of non-ferrous blades and their motors spark-proof. All equipment should be grounded. In fact, all spark-producing equipment

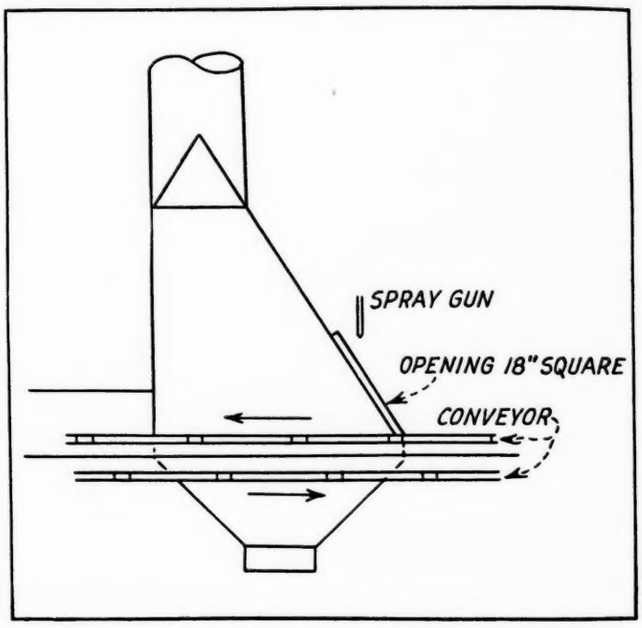


Fig. 78. Another type of booth arrangement for mechanical conveyor.

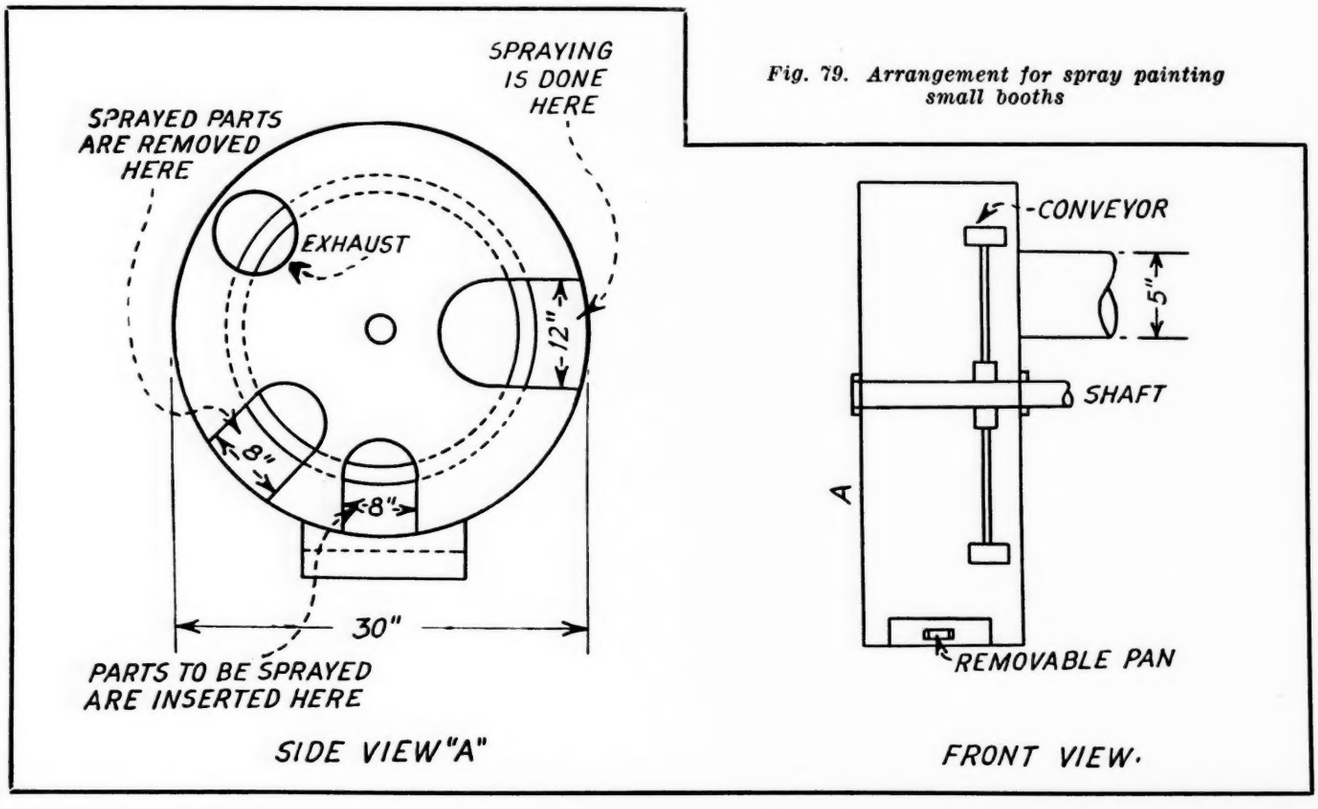


Fig. 79. Arrangement for spray painting small booths

should be located at a reasonable distance from the booth opening.

Where large surfaces are sprayed—requiring several operators at one time—it is preferable to utilize down-draft ventilation. Lateral ventilation is frequenly used with good effect, but workmen on the downstream side may be exposed to spray and vapors made by others upstream. Unless all workmen are provided with suitable respirators, this practice should be avoided. Downdraft ventilation is costly, since it requires rather large plenum chambers at the ceiling and floor, and two-fan systems. In this system air is introduced at the ceiling through slots spaced at such intervals as to distribute the air at the working level with a velocity of not less than 100 feet per minute. Grille-type openings at the floor are placed under suction and an amount of air exhausted equal to that supplied. It is customary to make the openings at the ceiling and floor of such a size that air velocities do not exceed 700 feet per minute. Floor grilles need not be located directly beneath the object being sprayed.

Conveyor or Mechanically Operated Spray Booths

The introduction of mechanically operated spray painting booths has done much to reduce the personal factors so important in control of vapors and mists in the stationary types. Operators are rarely required since the gun is fixed and usually operated by an electric eye; that is, spraying continues only as long as the object obscures the light beam. Gear arrangements also are used to rotate the object being sprayed as it moves along the conveyor.

Figs. 77 to 79 illustrate three types of mechanical spray booths. In Fig. 77, spraying is done from a horizontal position, while in Fig. 78 spraying is done vertically. Both types utilize a horizontal conveyor arrangement. In these types, an operator is not essential. The spray guns are fixed for maximum spray efficiency and operate at a predetermined fixed rate. Ducts should be designed for air velocities ranging from 1500 to 2000 feet per minute, while the air volumes handled, because of the speed with which work is done, should range from 150 to 200 cubic feet per minute per square foot of opening.

The rotary-type sprayer shown in Fig. 79 is for small parts. This sprayer requires the presence of an operator to insert the pieces on the rotary holder indicated in the figure. They are usually removed automatically. Spraying is controlled automatically, and usually with a highly volatile vehicle. For this reason, and because of the necessity to speed drying, large air volumes must be provided. For the automatic sprayer shown in the figure, the air volumes provided should approximate 200 cfm per square foot of opening.

(*In next month's installment Mr. Dalla Valle will discuss grille-type openings under suction.*)

Air Conditioning in Radar Tube Plant

Air conditioning is being used to facilitate the production of all-important radar and television tubes manufactured in the plant of the National Union Radio Corporation of Lansdale, Pa. Three air conditioning installations are operating in the National Union plant.

The company's chemical laboratory is equipped with a 55-ton industrial cooling system powered by a Chrysler Airtemp radial compressor. The system uses 100% outside air, which is cleaned by electric Precipitron cells and washed by sprays before passing through a bank of direct expansion coils.

Air cleaning is necessary to prevent rust within the system which might impair the quality of the emulsion used in the manufacture of the tubes.

The second installation is in a room where radar and television tubes are coated. This space is maintained at a constant relative humidity of 45% and a dry bulb temperature of 70F by two Airtemp packaged cooling units. The inside of the tubes and wires for the bulb cores are coated in this room.

In this process it is necessary that a constant humidity be maintained to preserve the dried coating on the tubes. Further, large volumes of absolutely clean outside air are required for spray booths. Powder emulsion sprayed in these booths is recovered and exhausted by mechanical means to assure absolute cleanliness in the room.

The third installation is in connection with testing tubes. It was observed that the spoilage of tubes was much greater on rainy days than on low humidity days. Testing apparatus for the radar tubes is a housing containing a large number of instruments which is ventilated to relieve the heat generated by the instruments. When temperature and humidity control equipment is not used, moisture in the air is deposited on the instruments, thus impairing their accuracy, and false readings are obtained.

To meet this condition a system was designed using an Airtemp packaged unit which handles 100% factory air, dehumidifying this air to an apparatus dewpoint of approximately 45F. This air is conducted at high velocity to ten testing apparatus housings where it enters a perforated distribution chamber, mounted on top of each apparatus. The dry bulb temperature of the air is kept at 70F.

The three installations were made by the George C. Lewis Co., Airtemp Philadelphia dealer. John Brey, Airtemp field engineer, assisted in the design and installation.

NEWS OF THE MONTH

Plating Room Ventilation

Los Angeles—In a talk on Ventilation of Electro-Plating Departments at the meeting of the American Electro-Platers Society here October 11, Carlyle Artran, engineer, General Air Conditioning Co., deplored the penny-pinching practice of many plating shop operators in trying to make a $15 exhaust fan in the sidewall handle the ventilation of motor generator rooms containing thousands of dollars worth of equipment.

Inasmuch as the generator is the most expensive single item in a plating department, Mr. Artran said it would seem logical to take out insurance in the form of a dust and temperature protective ventilating system of adequate capacity.

One of the most successful systems for generator rooms, Mr. Artran stated, consists of efficient air filters, an inexpensive multiblade fan and drive, piping to carry the air to the windings and commutator and properly sized relief air openings for the room. The room, he advised, should be kept under a slight pressure at all times to prevent the infiltration of dust and fumes, and the fresh air location should be carefully chosen to insure cool, clean air.

For large installations, Mr. Artran recommended the addition of evaporative cooling. For the protection of the exhaust fan operating on chrome plating tanks, he suggested the insertion of a separator in the pipe before it connects to the fan inlets; the separator, he said, could be of the inertia trap or centrifugal type. The latter type, he declared, is to be preferred as it requires less fan horsepower and is equally as effective in protecting the fan impeller and housing against chromic acid particles. The separator will also reduce the amount of corrosive particles thrown into the atmosphere, thus saving other departments from this hazard.

For high-production plating plants, the addition of an after-condenser was recommended by Mr. Artran. This condenser, he explained, usually used water to clean the exhaust air of chromic or other acid particles and fumes, and employs either sprays, straight impingement, or wetted pads of glass or other fibres. He stated the cost of such equipment to be warranted for large plants housing expensive machine tools or for locations where fume discharge must be at a minimum.

Electro-plating tank hoods of the rim-inlet type are relatively inefficient, the speaker asserted, but explained that this shape is dictated by the operation of loading, unloading and moving the work from tank to tank. The probable efficiency of the average tank hood drawing air trough slots along the sides will be about 40%, according to Mr. Artran, but this can be raised to about 50% by careful design.

Generally speaking, Mr. Artran summarized, plating shop operators are prone to expect too much from their ventilating equipment. Some, he said, expect an exhaust system to reach way out and draw forth the contaminated air from a room even though the flow of fumes or particles is greater than the suction power of the exhaust system.

In figuring air capacity required to exhaust a chromic acid tank, Mr. Artran said allowance should be made for 200 cu ft of air per minute per square foot of surface. Bright nickel tanks, he explained, require slightly less air capacity per minute.

If every single tank in the average plating shop were to be equipped with a hood and exhaust system, Mr. Artran stated, the cost would be entirely out of proportion to the income from such a plant. Sound practice for comparatively small plating shops, he said, would be to hood the caustic and soap tanks, and provide large draft fans in wall or on the roof to handle the ventilation of the work room in general. If the equipment is of sufficient air drawing capacity, this type of installation will serve the ventilating needs of the average shop, he said.

Fuel Saving Course in Boston

Boston—The Division of University Extension of the Massachusetts State Department of Education announces that Paul L. Geiringer, of Jackson and Moreland, will conduct a course on Fuel Saving in War Time, beginning Tuesday evening, November 16, at 7:45. The class will meet on Tuesday and Thursday evenings at Sever Hall, Harvard University, and is intended for all those who are in charge of heating systems in industrial plants, as well as in hotels, apartment buildings, etc. For further information regarding this course call the Division of University Extension, State Department of Education, 200 Newbury Street, Boston.

Officers of SMCNA

New York—Officers and directors of the newly formed Sheet Metal Contractors National Association have been elected as follows:

President, John S. Clark, The J. S. Clark Co., Inc., Detroit; first vice-president, J. E. Merrick, Falls City Cornice and Roofing Co., Louisville; second vice-president, Benjamin Kolbenschlag, Benj. Kolbenschlag Furnace & Sheet Metal Co., St. Louis; third vice-president, Patrick S. Varden, Varden Bros. Roofing Co., Albany; treasurer, Carl M. Gundlach, Gundlach Sheet Metal Works, Sandusky; secretary, Clarance J. Meyer, Joseph Meyer & Son, Inc., Buffalo; directors, three years, Richard E. Walsh, Thomas Finn Company, St. Paul; Frank A. Kramer, Kramer Sheet Metal Works, Milwaukee; Hugh A. Daniel, Atlas Roofing Co., Newburgh; directors, two years, Joseph J. Walter, Joseph J. Walter, Ottawa; Louis C. Trost, Trost Roofing & Sheet Metal Co., Erie; Max F. Liebermann; M. F. Liebermann & Son, Ambridge; directors, one year, Harvey L. Orton, The Orton Heating Company, Barberton; Dion A. Mannen, The Mannen & Roth Co., Cleveland; Rudolph H. Guenther, Accurate Sheet Metal Works, Chicago; sergeant-at-arms, Paul L. Biersach, Paul L. Biersach, Milwaukee.

Indoor Climate Institute Organized

DETROIT—At a meeting held in Cleveland, September 14, the Indoor Climate Institute was formally organized by leading manufacturers in the heating, cooling and equipment industries. The institute has, as its primary purpose, a program for the improvement of heating and air conditioning in the interests of public health and greater indoor comfort.

The I.C.I. membership insignia will stand as a symbol of greater indoor comfort to the American public. The Institute, a non-profit corporation, will have its headquarters in the new Center Building, Detroit. It will serve as a clearing house of information, set up with a central staff and committees qualified to conduct a broad program of public and trade education. The public will be informed as to the many benefits in health, comfort and economy resulting from properly designed and installed prime heating equipment—burning coal, gas or oil for warm air, hot water or steam heat.

Many practical objectives have been set up for the first year of operation for the Institute. A comprehensive study of manpower problems, now and for the post-war period is to be made. This will assist those in the heating and cooling industries to recruit and train personnel in the specialized skills required in the manufacture, distribution and installation of central heating and cooling systems. Technical committees have been set up to study the codes, standards and practices, as established by the various industry trade associations and authorities for the benefit of the public.

Executive personnel of I.C.I. is as follows: president, Paul B. Zimmerman, Airtemp Division, Chrysler Corporation; 1st vice-president, T. A. Crawford, Timken Silent Automatic Division; 2nd vice-president, E. N. Hunter, The National Radiator Co.; secretary, R. E. Moore, Bell & Gossett Company; treasurer, E. N. McDonnell, McDonnell & Miller.

The officers and the following compose the board of directors: A. T. Atwell, Quaker Mfg. Corp.; C. T. Burg, Iron Fireman Mfg. Co.; W. J. Grover, Surface Combustion Corp.; John Knighton, Servel, Inc.; C. D. Lyford, Minneapolis-Honeywell Regulator Co.; J. M. McClintock, Illinois Iron & Bolt Co.; John Rainbault, General Electric Co.; J. R. Scott, Mueller Furnace Co.; Jack Searls, White Rodgers Electric Co.; and W. L. Seelbach, Forest City Foundries Co.

The advisory council to the board is composed of: Homer Addams, Fitzgibbons Boiler Company, Inc.; Lyle C. Harvey. The Bryant Heater Company; Carroll E. Lewis, Delco Appliance Division, General Motors Corporation; W. L. McGrath, Williamson Heater Company; Albert Penn, Penn Electric Switch Co.; L. R. Ruthenberg, Servel, Inc.; E. C. Sammons, Iron Fireman Mfg. Co.; Arthur Shellenberger, Alco Valve Co.

ASRE Convention to Feature Post-War Symposium

PHILADELPHIA—At the 39th annual meeting of The American Society of Refrigerating Engineers, to be held here December 7-9 at the Benjamin Franklin Hotel, technical papers of exceptional value will bring members and interested guests up-to-date on refrigeration progress during the war period, and the Refrigeration Industry Forum, to be held December 9 at the Franklin Institute, is remarkable for its array of industry leaders who will speak.

The tentative technical portion of the program follows:

DECEMBER 7

"Refrigeration Controls", J. R. Vernon, Johnson Service Co.; "Refrigeration Applications for Blood Plasma and Biologicals," Lieut.-Col. Douglas B. Kendrick, Walter Reed Hospital; "Freon-22 and Its Application to Low Temperature Refrigeration Units," J. W. Craig, Crosley Corp.

DECEMBER 8—A.M.

"Adsorption of Vapors—Some Practical Experience in Ventilation," F. H. Munkelt, W. B. Connor Engineering Corp.; "Refrigerating Design Problems in Marine Installations," Prof. F. W. Hutchinson, University of California.; "Cost of Operation of Refrigeration Used for Air Conditioning", Realto E. Cherne, Carrier Corp. Presentation of Wolverine Award for best paper published in *Refrigerating Engineering* during the past year.

DECEMBER 8—P.M.

"Domestic Freezing Cabinets," James K. Noel, Victor Products Corp.; "Locker Plants," Wayne Carver, Locker Publications Company; "Consumer Needs in Food Distribution and Storage," Miss Katherine Fisher, director, Good Housekeeping Institute; "Dehydration and Food Compression," B. E. Proctor, director, subsistence and packaging research, Office Quartermaster General, U. S. Army.

DECEMBER 9—A.M.; SYMPOSIUM

"Future Demands for Refrigeration and Air Conditioning"; Speaker, H. L. Andrews, vice president, General Electric Co.; Commentators, C. E. Wilson, vice president, Worthington Pump and Machinery Corp.; J. S. Forbes, president, Superior Valve and Fittings Co.

"New Equipment to Meet These Demands"; Speaker, Norman Bel Geddes, industrial designer; Commentators, F. S. McNeal, president, Universal Cooler Corp.; J. H. Ashbaugh, manager, merchandising division, Westinghouse Electric and Mfg. Co.

"Distribution, Sales and Promotional Methods for a Greater Industry; Speaker D. W. Russell, president, Airtemp Division, Chrysler Corp.; Commentators, W. Paul Jones, vice president, Philco Corp.; Charles T. Lawson, sales manager, Kelvinator Div., Nash-Kelvinator Corp.

"Our Industry, the Government and the Public"; Speaker, Cloud Wampler, president, Carrier Corp.; Commentators, S. E. Lauer, president, York Corp.; R. E. Cosgrove, vice-president, Crosley Corp.

Gas A.C., Kitchen Ventilating Advocated

LOS ANGELES—Air conditioning of homes with gas powered units will be one of the major developments to which the gas industry can look forward in the post-war period, C. V. Sorenson, Hammond, Ind., chairman of the sub-committee on post-war potential markets of the American Gas Association, stated at the 50th annual convention of the Pacific Gas Association at Los Angeles on September 23.

The need for improved kitchen ventilating was stressed by H. E. Masser of Los Angeles, chairman of the Association's committee on gas industry development.

Consulting Engineers Aid Fuel Conservation

WASHINGTON — Increased fuel conservation and improved heating comfort for war workers through greater efficiency in the operation of heating equipment next winter are expected to result from studies recently completed by heating engineers from private industry at war housing projects in various sections of the country, it was announced Sept. 27 by the Federal Public Housing Authority.

Decision to employ consulting engineers to make surveys and recommendations on war housing heating equipment was made by the FPHA in an effort to conserve fuel and to secure reasonable heat comfort for war workers this winter. Guidance was found to be particularly needed at projects with individual tenant-operated heating equipment, but a higher degree of efficiency is also sought by FPHA in the operation of equipment in centrally heated projects.

The findings and recommendations resulting from the studies are set forth in a "Heating Correction Guide" now being distributed by the FPHA to war housing project managers and tenants. The guide contains common causes leading to unsatisfactory heating conditions and recommends solutions. Experts report that unsatisfactory heating is frequently traceable to the use of improper coal.

The guide covers four types of heating equipment: (1) forced warm air (project operated) non-circulating systems; (2) forced warm air (project operated) recirculating systems; (3) forced warm air (tenant operated); and (4) individual space heaters.

On account of war restrictions on the use of gas and oil fuels, the publicly-financed war housing projects are to a large extent heated with coal-fired equipment. Discontinuance of oil heating equipment was ordered in all projects where feasible early in 1942, and many of the older publicly-financed projects have been converted from oil to coal-fired equipment within the last year.

The consulting engineers who surveyed the heating equipment in the war housing projects were William K. Karsunky, Washington, D. C., Krey & Hunt, New York, and Warren & Ronald, Louisville.

Cooling Will Prevent Fumes from Butadiene Plant

LOS ANGELES—Defense Plant Corp. has authorized the installation of $500,000 in auxiliary cooling equipment and a new cooling tower housing in the Southern California Gas Co.'s recently completed butadiene plant here as a means of preventing the dispersement of noxious fumes thrown off during cooling operations.

The release of irritating fumes has been such that the plant early in October was ordered shut down temporarily by the city council of Los Angeles, pending correction of the fume evil. Engineers concluded that the eye-irritating fumes resulted primarily from the difficulty of separating oils from cooling water.

New equipment now being installed includes a water clarification system and a closed cooling system in the form of a housing fitting over the existing cooling tower.

Indiana Chapter of ASHVE Organized

INDIANAPOLIS—The Indiana chapter of the ASHVE received its charter from Pres. M. F. Blankin at a dinner meeting at the Columbia Club here November 1.

Officers of the newly organized chapter, who were installed in the presence of members of the Council of the Society, are: president, S. E. Fenstermaker; vice-president, W. C. Bevington; secretary, C. W. Stewart; treasurer, L. W. Clark; board of governors, C. H. Hagedon, Prof. W. T. Miller and G. B. Supple.

The speaker of the evening, Dr. B. M. Woods, director of the University Extension, University of California, Berkeley, Calif., spoke on "How to Plan for the Future of Air Conditioning." In his talk he discussed some of the post-war problems of the profession and explained the role of the engineer in solving the problems that will develop in meeting the public demand for heating and ventilating and air conditioning problems in the future.

Konzo Promoted

URBANA, ILL.—S. Konzo has been promoted to a full professorship with the title Special Research Professor at the University of Illinois. Professor Konzo has long been identified with the various phases of heating research carried on at the University.

50th ASHVE Meeting Plans Under Way

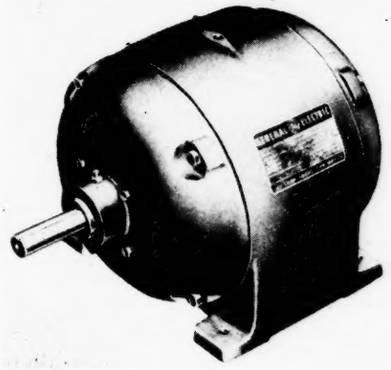
NEW YORK — Plans for the 50th Anniversary Meeting of the American Society of Heating and Ventilating Engineers are well under way and the Committee on Arrangements is preparing a program of special events for the business and technical sessions. Among the group of papers to be presented are, tentatively, those on a study of intermittent heating of churches; heat distribution in heating and cooling panels; air distribution problems; comfort data studies; engineering theories and practices for the past 50 years; and fuel conservation.

An active group of committees has been announced by General Chairman Alfred J. Offner, with Harry S. Wheller in charge of hospitality, Mr. and Mrs. H. J. Ryan, ladies; E. J. Ritchie, sessions; Alfred Engle, banquet; A. C. Buensod, special events; C. S. Pabst, inspection; R. V. Sawhill, publicity; C. F. Roth, N. Y. chapter special committee; and W. M. Heebner, finance.

At the opening session the organization of the Society will be commemorated and a portion of this program will include the introduction of distinguished guests and the presentation of representatives of allied organizations. Reports of officers and committees will be presented and action will be taken on by-law amendments.

The headquarters selected for the 50th Annual Meeting is Hotel Pennsylvania at 32nd St. and 7th Ave., New York, where registration will commence January 31, 1944.

NEWS OF EQUIPMENT AND MATERIALS

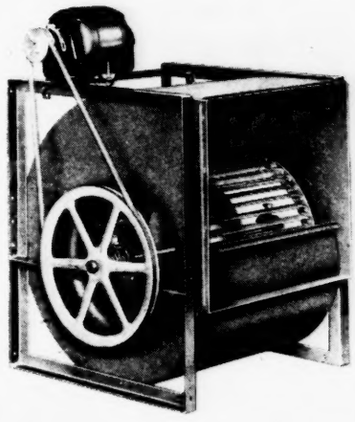


Totally Enclosed Motors

NAME—Totally enclosed tri-clad motors.
PURPOSE—For use where abrasives, chemicals, rain, snow and excessive dirt are encountered.
FEATURES—New additions to the above standard line have the same basic features as previous units, including cast iron motor frames, end shields and conduit boxes; Formex wiring; a rotating labyrinth seal which prevents dirt, oil or water from entering the bearing housing; and with leads permanently encased in a compound to prevent seepage of liquids into the motor. Mounting dimensions interchangeable with tri-clad open type motors of same rating.
SIZES AND CAPACITIES—Polyphase type in frame sizes 203 to 225. ½ to 2 hp, and 900, 1200, 1800 and 3600 rpm. Single phase in frame sizes 203 and 204, ¾ to 2 hp, speeds 1200, 1800 and 3600 rpm.
MADE BY—*General Electric Company, Schenectady, N. Y.*

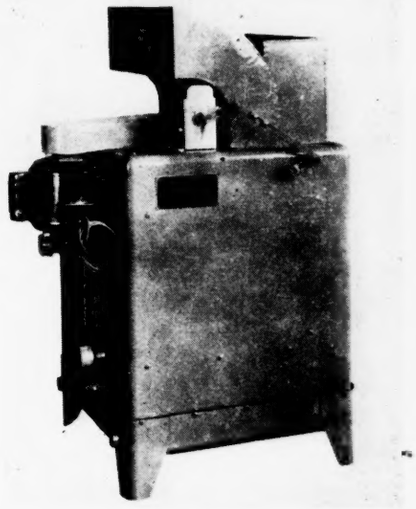
Dunham OTS Convector Element

NAME—Dunham type OTS convector heating element.
PURPOSE—Made of steel to conserve more critical metals. Long and narrow and suitable for installations where standard type units are not desirable.
FEATURES—Each element made of 1¼ in. pipe with 22-gage fins mechanically attached. Fin design is unique in that each fin when pressed to pipe interlocks to preceding fin, assuring greater contact area. Unit is painted with heat resisting zinc chromate black enamel. Single pipe feature permits high, safe working pressures. Covers available for all lengths of units, constructed of 16 gage metal. Covers reduce rated capacity approximately 3%.
SIZES AND CAPACITIES—Available in six lengths from 18 to 72 in. with a capacity from 1880 to 7685 Btu per hr with 1 lb steam and 65F entering air temperature. Multiple lengths can be supplied by coupling two or more units together.
LITERATURE AVAILABLE—Bulletin 629.
MADE BY—*C. A. Dunham Company, 450 E. Ohio St., Chicago 11, Ill.*



Four-Way Discharge Blower

NAME—No. 3 arrangement standard duty blower.
PURPOSE—Ventilating blower with four-way discharge.
FEATURES—Four-way discharge permits installation in any one of the following discharge positions: top horizontal, top vertical, bottom horizontal, bottom vertical. Blowers are furnished with bearings assembled for top horizontal discharge; only a simple change in the bearing position is involved in conveniently altering the discharge of the blower even on the job itself. Belt-driven. Accompanying illustration shows a unit in top horizontal position.
SIZES AND CAPACITIES—9 to 24 in. wheel diameter, single inlet, single width, and double inlet, double width.
MADE BY—*Utility Fan Corporation, 4851 S. Almeda St., Los Angeles 11, Calif.*



Niagara After-Cooler

NAME—Niagara Aero After-cooler.
PURPOSE—For cooling compressed air and gas.
FEATURES—Cooling of compressed air results in drier air and prevents water damage to pneumatic equipment, and damage to work in such cases as paint spray equipment. Device uses evaporative cooling principles to obtain lower temperatures. New design gives greatly increased capacity in compact apparatus. Air, drawn by a fan through water spray across coils containing the compressed air for the cooling medium and temperatures within 10F of the wet bulb air temperature can be maintained. Device is said to give lower temperatures by 10F to 25% than conventional coolers and is said to produce air that is only one-half to three-quarters the amount formerly experienced. Equipment is also applied to gases generated for industrial use.
MADE BY—*Niagara Blower Co., 6 E. 45th St., New York 17, N. Y.*

Reanite Bonding

NAME—Reanite bonding process.
PURPOSE—A method of bonding metals, rubber, synthetics, plastics, leather, and so forth to one another or to each other with a bond stronger than the materials themselves.
FEATURES—Suitable for use with almost all metals as well as many other materials. Application of process is simply by brushing, spraying, or tipping with Reanite before joining them. After drying, apply mild heat and pressure.
MADE BY—*The U. S. Stoneware Co., Akron, Ohio.*

Fairbanks-Morse Motor

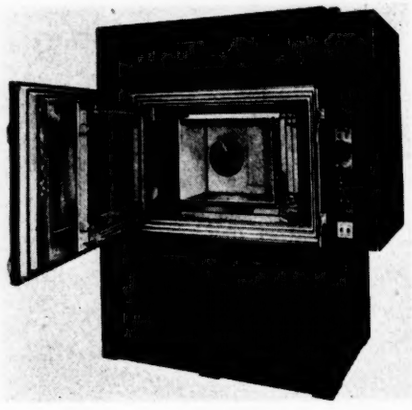
NAME — All-purpose, continuous-duty, polyphase squirrel-cage induction motor.
PURPOSE—For use in all kinds of industry. This new motor is "protectioneered" and according to the company, embodies many special and vital features that will be viewed with extreme interest by motor users everywhere.
FEATURES—Constructed with centrifugally-cast F-M Copperspun rotor, this new motor is fully protected against flying chips, falling particles, dripping liquids, and other industrial motor hazards. Ball bearings sealed in cartridge-type housings minimize expensive shut-downs due to bearing failures. Cross-flow ventilation, a feature in frames 224 to 365 inclusive, is obtained through protected inlets and exhausts at each end of the motor.
SIZES AND CAPACITIES—It is rated 40°C and designed to carry 115% load continuously without injurious heating (1.15% service factor); ½ to 600 hp, 450 to 3600 rpm syn. speed.
LITERATURE AVAILABLE — Bulletin 1160.
MADE BY—*Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill.*

Metal Projector

NAME—Serviron.
PURPOSE—For corrosion-proofing boiler and tank interiors.
FEATURES—A permanently plastic material applied like paint for protection of boiler drums, metal, wood, concrete storage tanks, or other under-water surfaces against corrosion and fungus growths. Retaining its flexibility indefinitely, it is said to be free from any cracking due to temperature changes or to melting, freezing, cracking, or chipping at temperatures from below freezing to 550F. Withstands certain acids, brines, and caustics, according to the maker.
MADE BY—*Saverite Engineering Co., Hoboken, N. J.*

Vertical D-C Motors

NAME—G.E. direct current vertical motors.
PURPOSE — For low-thrust solid shaft applications on pumps, tools, and auxiliaries, and where floor space must be saved or gearing expense avoided.
FEATURES—Motors are of drip proof protected construction providing protection from dripping liquids and falling objects. Convenient fittings on bearings, simplified lubrication; cast iron conduit box is roomy.
SIZE AND CAPACITY—From 40 to 200 hp at 1750 rpm for both constant and adjustable speeds.
MANUFACTURER—*General Electric Company, Schenectady, N. Y.*



High Altitude Test Chamber

NAME—Amcoil high altitude test chamber.
PURPOSE — Refrigeration cabinet with enclosed vacuum chamber with air space completely surrounding it for testing aviation equipment.
FEATURES—Above vacuum chamber a coil is mounted to take care of the cabinet load itself. In addition, interior of chamber is equipped with coil and forced air unit so that heat dissipation from motors can be carried away by refrigeration system rather than by heat transfer through wall. Consequently, it is possible to obtain low temperatures quickly and under actual ambient temperature conditions. Has floating glass seal. Changes in test procedure, requiring holes, shafts or leads, can be made without disturbing refrigeration equipment.
SIZES AND CAPACITIES—Model RAC-11 has cabinet contents of 8 cu ft. Model RAC-22 has 11 cu ft of usable interior. Temperature range is from —70C or —55C to 70C; pressure from atmospheric to 60,000 feet.
LITERATURE AVAILABLE — Descriptive data sheet.
MADE BY—*American Coils Company, 27 Lexington St., Newark, N. J.*

Leather V-Belt

NAME—Schieren Leather V Belt.
PURPOSE—Power Transmission.
FEATURES—Consists of a V-shaped leather core to which full grain flat leather sides are cemented, insuring an improved groove grip and a higher belt co-efficient, according to the manufacturer. Belts come in long rolls, and may be cut and made endless on the job or in the stock room by use of special tools available. Photo shows a mitre box provided with clamps to firmly hold the ends together during cementing process. This feature eliminates need for large costly inventories of various sizes of belts. Improved belt life and decreased wear on bearings are said to result from ability to run belts slack, due to good friction co-efficient.
SIZE AND CAPACITY—Belts supplied in rolls of 3 standard sizes.
MADE BY—*Chas. A. Schieren Co., 30 Ferry St., New York.*

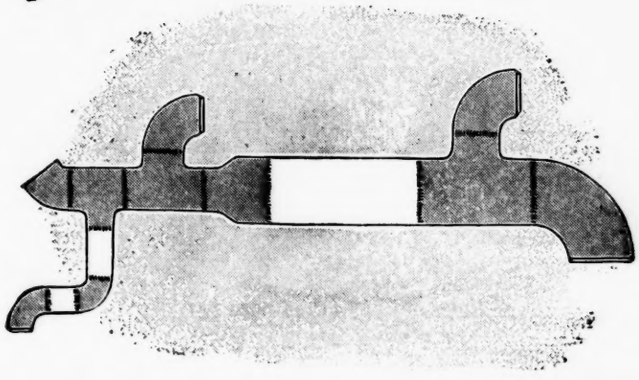
Slide Rule Calculator

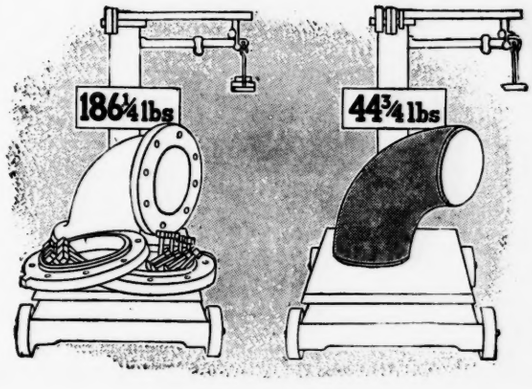
NAME—Compressor Calculator.
PURPOSE — Time saving slide rule for rapid calculation of air compressor requirements and performance.
FEATURES — A pocket size heavy cardboard slide rule based on many years of compressor-building experience. It can be used for quick estimation of volumetric efficiency, brake horsepower, and total piston displacement of compressor. Sent gratis by the manufacturer.
MADE BY—*The Cooper-Bessemer Corp., Mount Vernon, Ohio.*

NO. 10 OF A SERIES
HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

The FIRST SEAMLESS WELDING FITTINGS 1ST AND STILL THE BEST

Improve industrial piping 4 ways with Tube-Turn welding fittings!



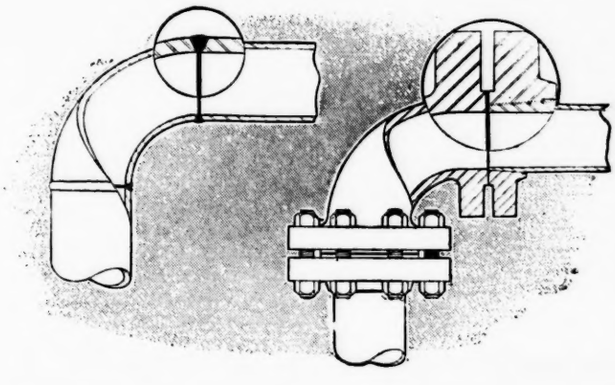


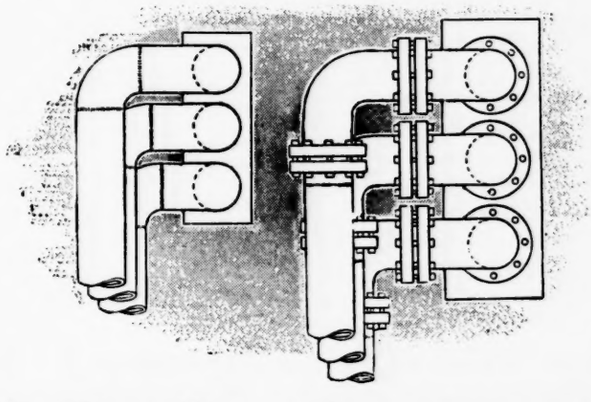
1. Easily preassembled—speed installation

Save from 50% to 75% time by pre-assembling difficult piping sections like this in the shop. Tube-Turn fittings are ready to use. They simplify lining-up, require only easy, circumferential butt welds. This insures faster, better and safer welding by either veteran or novice welders—a real war production help.

2. Reduce weight—conserve materials

Look at the weight saved by using an 8" Tube-Turn elbow instead of a heavy 8" cast iron flanged ell with companion flanges, studs and nuts. Multiply this saving by the many fittings in any piping system and it's easy to see how Tube-Turn fittings save tons of weight, metal and critical materials.





3. Avoid "down time"—reduce maintenance

Note how the welded connection virtually forms a continuous tube without joints—insures permanently leakproof, trouble-free connections that last as long as the pipe itself! Such maintenance headaches as leaks, gasket changes, bolt tightening, caulking, threading, and difficult insulatings are totally eliminated.

4. Streamline systems—save space

Contrast the space saved in these compound turns by using Tube-Turn elbows instead of flanges. Tube-Turn fittings require less space, permit streamlined, compact layouts and neater, more efficient piping. Elbows can be cut to any odd angle. Saving space is important in most industries, is vital in shipbuilding!

TUBE TURNS (INC.) Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle. *Distributors in principal cities.*

TUBE-TURN *Welding Fittings and Flanges*

Buy another War Bond this week!

Degree-Days for September, 1943

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1943	Degree-Days, Sept., 1942	Degree-Days, Sept., Normal	Season, 9/1/43-9/30/43	Season, 9/1/42-9/30/42	Season, Normal, 9/1-9/30	Normal, 9/1-6/30
Abilene, Tex.	8	19	0	8	19	0	2061
Albany, N. Y.	190	172	72	190	172	72	6580
Albuquerque, N. Mex.	14	16	0	14	16	0	4298
Alpena, Mich.	302	273	222	302	273	222	8299*
Anaconda, Mont.	224	263	335	224	263	335	8357**
Asheville, N. C.	114	86	0	114	86	0	4232
Atlanta, Ga.	23	37	0	23	37	0	2890
Atlantic City, N. J.	69	66	0	69	66	0	5176
Augusta, Ga.	1	18	0	1	18	0	2161
Baker, Ore.	114	187	258	114	187	258	7163
Baltimore, Md.	54	50	0	54	50	0	4533
Billings, Mont.	169	236	189	169	236	189	7119
Binghamton, N. Y.	195	157	108	195	157	108	6808
Birmingham, Ala.	20	35	0	20	35	0	2352
Bismarck, N. D.	229	351	222	229	351	222	9192
Block Island, R. I.	89	91	0	89	91	0	5788
Boise, Idaho	37	106	102	37	106	102	5552
Boston, Mass.	120	103	48	120	103	48	6045
Bozeman, Mont.	263	297	336	263	297	336	8521**
Buffalo, N. Y.	191	154	75	191	154	75	6822
Burlington, Vt.	230	223	144	230	223	144	7514
Butte, Mont.	295	335	344	295	335	344	8272
Cairo, Ill.	37	74	0	37	74	0	3909
Canton, N. Y.	268	230	189	268	230	189	8020
Charles City, Iowa	246	261	93	246	261	93	7588
Charleston, S. C.	0	8	0	0	8	0	1769
Charlotte, N. C.	36	38	0	36	38	0	3120
Chattanooga, Tenn.	24	61	0	24	61	0	3118
Cheyenne, Wyo.	225	291	240	225	291	240	7466
Chicago, Ill.	167	193	0	167	193	0	5957
Cincinnati, Ohio	88	135	0	88	135	0	4684
Cleveland, Ohio	134	135	27	134	135	27	6155
Columbia, Mo.	82	145	0	82	145	0	4922
Columbia, S. C.	7	21	0	7	21	0	2364
Columbus, Ohio	246	261	93	246	261	93	7588
Concord, N. H.	246	190	168	246	190	168	7353
Concordia, Kan.	62	151	0	62	151	0	5315
Dallas, Tex.	1	34	0	1	34	0	2256
Davenport, Iowa	136	183	0	136	183	0	6289
Dayton, Ohio	130	136	0	130	136	0	5264
Denver, Colo.	93	153	72	93	153	72	5874
Des Moines, Iowa	160	193	0	160	193	0	6384
Detroit, Mich.	171	188	42	171	188	42	6490
Devils Lake, N. D.	311	404	276	311	404	276	9970
Dodge City, Kan.	44	99	0	44	99	0	5035
Dubuque, Iowa	191	213	36	191	213	36	6790
Duluth, Minn.	374	357	270	374	357	270	9443
Eastport, Me.	277	253	276	277	253	276	8520**
Elkins, W. Va.	215	140	63	215	140	63	5697
El Paso, Tex.	14	7	0	14	7	0	2428
Ely, Nev.	170	281	—	170	281	—	—
Erie, Pa.	137	120	36	137	120	36	6273
Escanaba, Mich.	343	310	243	343	310	243	8771*
Evansville, Ind.	84	126	0	84	126	0	4244
Fort Smith, Ark.	0	51	0	0	51	0	3147
Fort Wayne, Ind.	203	184	0	203	184	0	5925
Fort Worth, Tex.	3	21	0	3	21	0	2148
Fresno, Calif.	0	0	0	0	0	0	2334
Galveston, Tex.	0	7	0	0	7	0	1016
Grand Junction, Colo.	2	39	0	2	39	0	5548
Grand Rapids, Mich.	188	192	57	188	192	57	6535
Green Bay, Wis.	272	258	132	272	258	132	7825
Greensboro, N. C.	68	59	0	68	59	0	3529
Greenville, S. C.	33	34	0	33	34	0	3380
Harrisburg, Pa.	109	92	0	109	92	0	5375
Hartford, Conn.	129	110	48	129	110	48	6036
Hatteras, N. C.	6	2	0	6	2	0	2571
Havre, Mont.	231	245	270	231	245	270	8700
Helena, Mont.	226	278	251	226	278	251	7898
Houston, Tex.	2	15	0	2	15	0	1157
Huron, S. D.	209	299	123	209	299	123	8004
Indianapolis, Ind.	112	133	0	112	133	0	5298
Ithaca, N. Y.	(a)	182	96	(a)	182	96	6719
Kansas City, Mo.	60	136	0	60	136	0	4956
Kewanee, Ill.	170	186	0	170	186	0	6139
Knoxville, Tenn.	44	75	0	44	75	0	3670
La Crosse, Wis.	251	238	96	251	238	96	7322
Lander, Wyo.	191	253	276	191	253	276	7947

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table Concluded on page 92.

Why Jimmy's girl sees him oftener now...

JIMMY FROWNED as he picked up the phone and dialed his number.

"Hello, Kid," he mumbled, "it looks like I can't be seein' you tonight either."

The voice at the other end of the wire said "Oh,"—coldly.

"Look" said Jimmy, "it's that darn strip coiler. The motor quit again this afternoon, and the boss says we'll have to work late and replace it . . . "

This little story could have several endings. But, in the case of a large aluminum company where Jimmy worked, the facts are these:

To prevent strip coiler motors from overheating, a constant current of air was kept blowing across the armatures. But, plant engineers and machine operators discovered, to their dismay, that manufactured dusts and grime in this cooling air were too frequently getting inside the motors and causing failures.

To overcome this condition, the engineers installed Dust-Stop* Filters in the air duct opening behind each motor. Result: Clean dust-free air now helps keep the strip coilers on the job all day—every day . . . producing aluminum at peak capacity.

So, Jimmy's girl sees him oftener now.

★ ★ ★

Today's heavy war production requirements have brought to light many new uses for Dust-Stop Air Filters.

These filters are being used in tool grinding machines, portable radio transmitters, paint-spray booths, welding unit and electrical-equipment installations. They are removing manufactured dusts in assembly and precision-parts operations . . . in factories, laboratories, and drafting rooms.

For complete engineering and installation information about Dust-Stops write to *Owens-Corning Fiberglas Corporation, Toledo 1, Ohio. In Canada, Fiberglas Canada, Ltd., Oshawa, Ontario.*

ARMY E NAVY

FIBERGLAS*

DUSTOP

*T. M. Reg. U. S. Pat. Off.

AIR FILTERS

Degree-Days for September, 1943 (Concluded)

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1943	Degree-Days, Sept., 1942	Degree-Days, Sept., Normal	Season, 9/1/43-9/30/43	Season, 9/1/42-9/30/42	Season, Normal, 9/1-9/30	Normal, 9/1-6/30
Lansing, Mich.	255	238	114	255	238	114	7048
Lewiston, Me.	(a)	204	165	(a)	204	165	7707
Lincoln, Neb.	84	174	0	84	174	0	5999
Little Rock, Ark.	3	57	0	3	57	0	2811
Livingston, Mont.	213	308	227	213	308	227	7205
Los Angeles, Calif.	0	3	0	0	3	0	1504
Louisville, Ky.	61	107	0	61	107	0	4180
Lynchburg, Va.	66	60	0	66	60	0	3980
Macon, Ga.	7	23	0	7	23	0	2201
Madison, Wis.	243	231	87	243	231	87	7429
Marquette, Mich.	334	310	225	334	310	225	8693*
Memphis, Tenn.	21	61	0	21	61	0	2950
Meridian, Miss.	3	36	0	3	36	0	2160
Milwaukee, Wis.	235	238	84	235	238	84	7245
Minneapolis, Minn.	236	282	93	236	282	93	7850
Modena, Utah	64	162	156	64	162	156	6562
Montgomery, Ala.	0	19	0	0	19	0	1884
Nantucket, Mass.	103	91	63	103	91	63	5957
Nashville, Tenn.	36	73	0	36	73	0	3507
New Haven, Conn.	111	91	39	111	91	39	5895
New Orleans, La.	0	5	0	0	5	0	1024
New York, N. Y.	65	53	0	65	53	0	5347
Nome, Alaska	—	—	—	—	—	—	14580**
Norfolk, Va.	27	24	0	27	24	0	3350
Northfield, Vt.	(a)	262	276	(a)	262	276	8719*
North Head, Wash.	208	238	255	208	238	255	5452**
North Platte, Neb.	110	201	42	110	201	42	6366
Oakland, Calif.	62	105	90	62	105	90	3143**
Oklahoma City, Okla.	1	66	0	1	66	0	3613
Omaha, Neb.	108	184	0	108	184	0	6131
Oswego, N. Y.	194	145	114	194	145	114	7088
Parkersburg, W. Va.	104	124	0	104	124	0	4775
Peoria, Ill.	151	189	3	151	189	3	6109
Philadelphia, Pa.	49	47	0	49	47	0	4855
Phoenix, Ariz.	0	0	0	0	0	0	1405
Pittsburgh, Penn.	112	108	0	112	108	0	5235
Pocatello, Idaho	86	161	156	86	161	156	6655
Portland, Me.	240	202	162	240	202	162	7218
Portland, Ore.	30	51	105	30	51	105	4469
Providence, R. I.	112	84	63	112	84	63	6015
Pueblo, Colo.	90	122	6	90	122	6	5514
Raleigh, N. C.	39	40	0	39	40	0	3234
Rapid City, S. D.	169	284	144	169	284	144	7118
Reading, Pa.	90	83	0	90	83	0	5389
Redding, Calif.	0	0	0	0	0	0	2451
Reno, Nev.	53	142	144	53	142	144	5892
Richmond, Va.	46	49	0	46	49	0	3695
Rochester, N. Y.	193	158	72	193	158	72	6732
Roseburg, Ore.	27	61	111	27	61	111	4428
Roswell, N. Mex.	18	49	0	18	49	0	3484
Sacramento, Calif.	0	2	0	0	2	0	2653
St. Joseph, Mo.	75	158	0	75	158	0	5161
St. Louis, Mo.	56	116	0	56	116	0	4585
Salt Lake City, Utah	26	110	18	26	110	18	5555
San Antonio, Tex.	10	13	0	10	13	0	1202
San Diego, Calif.	0	0	0	0	0	0	1645
Sandusky, Ohio	121	133	0	121	133	0	6208
San Francisco, Calif.	101	155	114	101	155	114	3264**
Sault Ste. Marie, Mich.	351	341	276	351	341	276	9285**
Savannah, Ga.	0	6	0	0	6	0	1490
Scranton, Pa.	157	128	60	157	128	60	6129
Seattle, Wash.	81	113	186	81	113	186	4934**
Sheridan, Wyo.	238	243	264	238	243	264	8008
Shreveport, La.	1	31	0	1	31	0	1938
Sioux City, Iowa	162	233	33	162	233	33	6898
Spokane, Wash.	92	120	192	92	120	192	6355
Springfield, Ill.	82	148	0	82	148	0	5373
Springfield, Mo.	84	130	0	84	130	0	4428
Syracuse, N. Y.	209	167	96	209	167	96	6893
Tacoma, Wash.	129	143	207	129	143	207	5181**
Terre Haute, Ind.	105	127	0	105	127	0	4872
Toledo, Ohio	194	164	9	194	164	9	6077
Topeka, Kan.	44	134	0	44	134	0	4969
Trenton, N. J.	88	66	0	88	66	0	4933
Utica, N. Y.	225	176	182	225	176	182	6796
Valentine, Neb.	166	264	93	166	264	93	7039
Walla Walla, Wash.	13	29	30	13	29	30	4808
Washington, D. C.	64	59	0	64	59	0	4626
Wichita, Kan.	18	114	0	18	114	0	4673
Williston, N. D.	262	333	270	262	333	270	9323
Winnemucca, Nev.	28	135	192	28	135	192	6427**
Yakima, Wash.	18	32	120	18	32	120	5599

*Includes August. **Includes July and August. (a) Data not yet available.

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

The women

They know that this is war, and that the price of victory will be high. They have sent off their sons, brothers and husbands to the armed forces, and they are coming out of beauty shops and offices, stores and homes, and are taking war jobs in steel mills and shipyards. The deft hands that in peacetime wielded the skillet and the dryer are now managing the boring mill and the welding torch—and to very good effect.

Ever try keeping traffic flowing smoothly in and out of the main entrance of a big steel plant? Ever knock a "hot top" off an ingot? Or rough-bore a gun forging? Or weld a ship's hull? Not women's work? Women are every day doing these and dozens of other jobs in Bethlehem shipyards and steel plants, and doing them superbly.

At Bethlehem and Lackawanna, at Baltimore, at Fore River and Hingham, on the Pacific Coast—and at other locations where this company operates plants and shipyards—former clerks and beauty-shop operators, saleslgirls and housewives, are applying themselves to their new, challenging tasks with wonderful spirit and skill. They are helping to swell the mighty output of steel and ships and ordnance. The results of their efforts are being painfully felt in Tokyo and Berlin. Hats off to them!

★ ★ ★ BETHLEHEM STEEL ★ ★ ★

Woman "patrolman" at a Bethlehem steel plant. Here is a job calling for plenty of tact and skill! Women are serving on patrol duty at gates, parking lots, offices, and other locations with efficiency and aplomb.

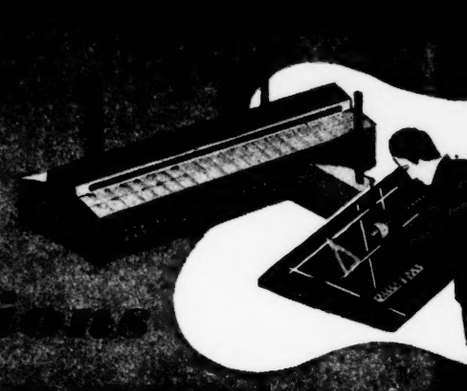
Once a dancer, now she runs a machine in a Bethlehem shipyard.

This "buggy" operator is hauling naval shells in a Bethlehem plant.

Upswept hairdo, red finger-nails, don't keep this girl welder from doing a man-size job at a Bethlehem shipyard.

REVIEWS

of TECHNICAL publications



REFRIGERATION

"Refrigeration Theory and Applications," by H. G. Venemann, Associate Professor of Refrigeration, Purdue University. Size 8¾ x 11¼ in., cloth flexible binding, 264 pages, multilithed, with numerous folding charts. Published by Nickerson & Collins Co., Chicago. Price $3.50.

Intended as a textbook on fundamental principles involved in the process of refrigeration, this book is primarily designed for student use not only to cover the process of refrigeration but to enable him to correctly interpret situations which may arise during operation of a plan. It is divided into twenty parts or lessons covering refrigeration charts, refrigeration by sensible heat process, refrigeration by sublimation and melting, refrigeration by melting mixture of salt and ice, refrigeration by evaporation, cooling the refrigerant, compression, cooling and condensation, refrigerants, air as a refrigerant, the theoretical compression cycle, variable loads and their influence on compressor performance, theoretical performance characteristics of a compressor, the actual compressor cycle, methods of accommodating variable loads, heat exchangers for cooling air, heat exchangers for cooling liquids, heat exchangers for condensing vapors, automatic controls, estimating plant loads, specifications for refrigeration plant.

The book includes problems with each section. It is profusely illustrated and includes, in addition, numerous tables of data useful for the student and pertinent to the subject. The author, who had a wide background of practical refrigeration experience, has presented in this book a complete treatise on fundamental principles which is certainly to be recommended.

PIPING DESIGN

"How to Size Piping for Steam, Gases and Vapors," by E. N. Kemler, Professor of Mechanical Engineering, Purdue University. Size 8⅛ x 11¼ in., ten pages, the eleventh of a series of reference sections published by HEATING AND VENTILATING, 148 Lafayette Street, New York 13, N. Y. Price 25c.

The feature of this pamphlet is a series of seven charts covering pipe sizes ranging from ⅜ to 8 in. pipe and which can be used to size piping for any gas, two of the variables in the charts being the specific gravity and kinematic viscosity of the fluid flowing. Booklet includes full information on use of charts as well as all supplementary data needed for use of the charts, in connection with steam, various refrigerants, other gases and vapors.

CLIMATE AND MAN

"Climate and the Energy of Nations," by S. F. Markham, 5¾ x 9 in., 144 pages. Published by the Oxford University Press. Price $3.75.

"Lincoln-Douglas; The Weather as Destiny," by William F. Petersen. 6 x 9 in., 212 pages. Published by Charles C. Thomas, Springfield, Ill. Price $3.00.

These two books to some extent supplement each other due to their common objective in showing the effect of climate and weather on mankind—the former on civilization as a whole, the latter on the individual.

Mr. Markham's book covers to some degree the ground already traversed by such authors as Ellsworth Huntington, whose "Climate and Civilization" has become a classic in its field. The author discusses the causes of human energy and shows their close relationship to temperature, and then, in the discussion of climate as a factor, reaches the conclusion that one of the basic factors in modern civilization is man's control over climatic conditions; that the nation which has led the world, leads the world, and will lead the world is that nation which lives in a climate indoor and outdoor nearest to the ideal, provided always that its numbers are large enough to resist invasion by its rivals. In discussing the ideal outdoor climate, the author concludes that the conditions which are best for factory work will produce a rising civilization providing other things are equal and among these other things is clothing. The 70F annual isotherm is the optimum for civilization, according to the author, and he traces the rise of later civilizations in regions not touched by the 70F isotherm due to their control over indoor climate.

The author pays particular attention to air conditioning in connection with ideal indoor climate, and believes that as heating systems develop further, Northwest Europe and similar climatic areas will lead the world for a generation or so.

Although Mr. Markham's book makes profuse use of statistics and other data to arrive at his conclusions, it is only natural that his conclusions are still somewhat open to question.

Dr. Peterson has attempted to show that climate was to a large extent responsible for the differences in the personalities, psychology and physiology of two such dissimilar figures as Stephen Douglas and Abraham Lincoln. Dr. Peterson is well qualified to write on the subject by virtue of the great amount of work he has done in connection with the relation

(Concluded on page 96)

Illinois CONTROL SYSTEMS

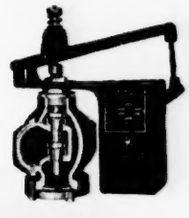
for Maximum Fuel Savings

To reduce fuel consumption and insure satisfactory steam circulation, look to the control of your heating system.

ILLINOIS Control Systems insure complete and accurate regulation of steam flow. There is a type to meet every heating condition in any installation, large or small.

Combustion Control . . . Flow Control — either Continuous Flow or "on and off" types . . . Modulation . . . and each system admits of special variations. Operation may be electrical or pneumatic, automatic or manual, or a combination of both.

Why not check up on your heating system now to have it at top efficiency for the winter months ahead?



Just drop us a line for bulletins and further details

ILLINOIS ENGINEERING COMPANY
INCORPORATED 1900
RACINE AVENUE AT 21ST STREET • CHICAGO

(Concluded from page 94)

between weather and health and it is to be presumed that the present work is an offshoot of his investigations in that field. Although some portions of the book show rather broad gaps in reasoning, nevertheless the author has written an extremely interesting and valuable work in correlating the meager data available in such a study.

Both books emphasize the very great importance of the atmospheric environment upon our lives as individuals and en masse. Both authors undoubtedly are well convinced that this atmospheric environment is one of the principal factors dominating our lives. Both books are to be highly recommended.

RADIANT HEATING AND COOLING

"Radiant Heating and Cooling—Part 1—Angle Factors for Calculations on Radiant Heating and Cooling," by C. O. Mackey, L. T. Wright, Jr., R. E. Clark and N. R. Gay. Published by the College of Engineering, Cornell University, Ithaca, N. Y.

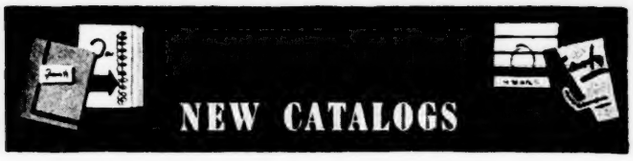
As a part of a study being supported by the Consolidated Edison Company into the various physiological, psychological and engineering factors related to radiant heating, the college has issued the first of a series of bulletins. In this 13-page bulletin, data, tables and charts are included for calculating angle factors from plane surface to plane surface, and from a small sphere to plane surfaces. Tables are given for angle factors within a specific test room.

BRIEF REVIEWS

COMBUSTION—A standard size, 58-page pamphlet, mimeographed, entitled "Manual of Instructions on Proper Firing Methods," published in the interest of fuel combustion and conservation, air pollution and smoke elimination. The booklet is the official publication of the Smoke Prevention Association of America, Inc., and includes the following papers: Preventing Spontaneous Combustion in Stores Coal; How to Reduce Smoke from Hand-Fired Furnaces; The Service Engineer; Underfeed Stokers; Practical Application of Statistical Methods for Controlling Coal Quality, and others.

MAINTENANCE—An 8¼ x 10¾ in. cloth bound beautifully printed and laid out book of 370 pages on "How to Maintain Electric Equipment." Distinctively treated by sections with wide margins and indexes in the margins and covering twenty-one different types of electrical equipment, including instruments, insulation, lighting, midget heaters, motors and generators, switchgear, and welders, and in addition contains three sections on technical data, renewal parts, and service shops. Published by General Electric Company, Schenectady, New York. Price $1.75.

PATENT LAW—A 225 page, cloth-bound book, by Chester H. Biesterfeld, a chemical engineer and member of the New York Bar and of The Bar of the District of Columbia, entitled "Patent Law" and intended for chemists, engineers, and students. The book is an outgrowth of the series of lectures given at the University of Delaware during recent years. Published by John Wiley & Sons, Inc., New York. Price $2.75.



FILTERS

Staynew Filter Corp., Rochester, N. Y.

A standard size, 40-page catalog 209, printed in two colors and devoted to the company's full line of industrial and ventilation filters. Includes schematic diagrams, drawings, photographs, capacity tables, and complete descriptions of automatic panel Wire-Klad and fibre frame filters as well as the Protecto-Vent window filters.

LEAD-SEALED STEEL SHEETS

Continental Steel Corp., Kokomo, Ind.

An informative manual on the company's lead sealed steel sheets. Publication is prepared especially for manufacturers who want to know how lead-sealed sheets will fit their products and production. Gives information on physical characteristics of the sheet, data pertaining to the lead alloy coating, gage and size limits, and tolerances. Supplements to the manual are planned from time to time as new uses and properties are discovered.

FUEL CONSERVATION

Marsh Tritrol Company, 600 S. Michigan Ave., Chicago.

A standard size, 16-page brochure covering in presentation form the basic points in the fuel conservation program and giving information on the relationship between fuel conservation and use of the company's outside-temperature-controlled temperature control.

FANS AND BLOWERS

International Engineering, Inc., Dayton, Ohio

Three standard size, loose-leaf-punched bulletins: No. 102, 8 pages, covers the company's line of duct boosters and stack fans. Shows applications of these axial flow fans in ships, as building ventilators, and in exhaust ventilating systems. Information includes data on water cooled stack fans and gives sizes, capacities and other specifications for the company's line; No. 103, 16 pages, covers axial flow fans other than duct boosters and shows applications and specification data on exhaust fans, 8-blade fans, noiseless type, Duo-Plane propeller fans, pressure fans, extended shaft fans, man cooling fans, blast coolers, portable blowers, penthouses, and fan guards; No. 104 is devoted to mine fans and shows application and specification data on this line.

AIR CONDITIONING

Westinghouse Electric and Manufacturing Company, East Springfield, Mass.

A standard size, 20-page bulletin 3AC-0201 covering industrial air conditioning and refrigeration and showing how these processes solve production problems. Illustrates and describes the company's hermetically-sealed compressor and traces its development from the 1932 models up to present design. Includes explanations and diagrams explaining the principles of air conditioning.

(Continued on page 98)

STOKERS FOR SCOTCH TYPE BOILERS ONLY

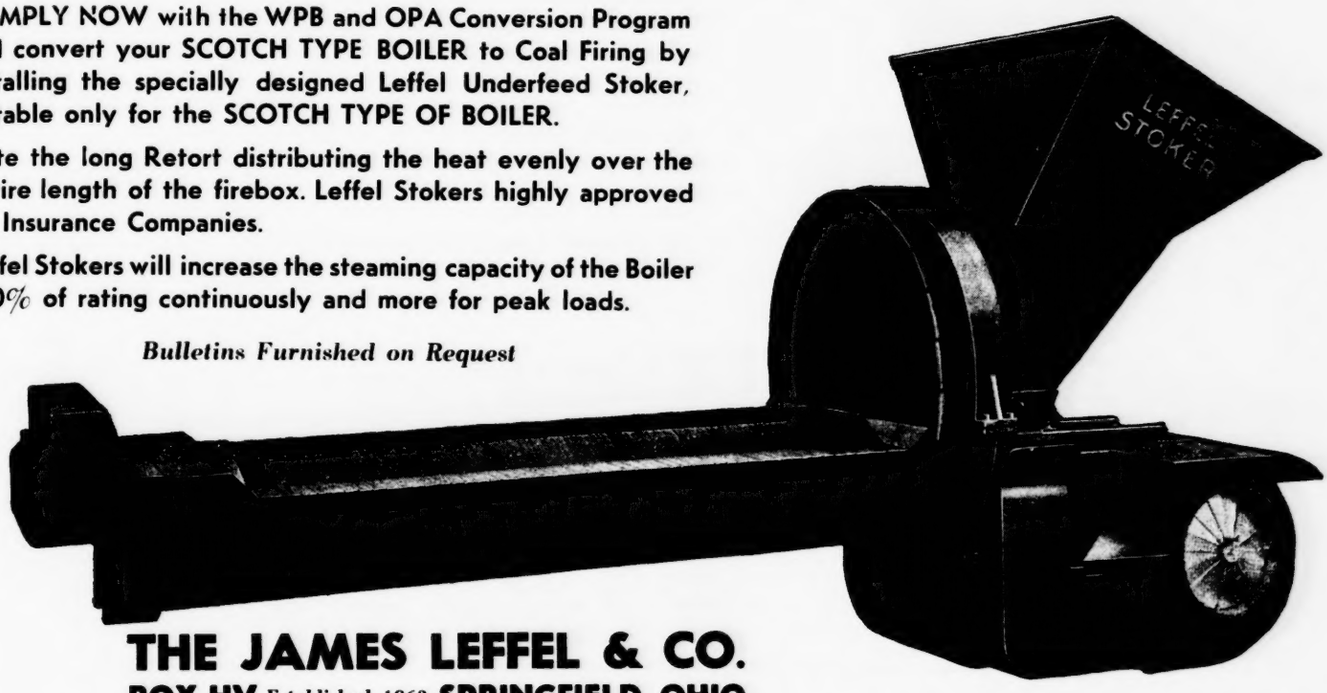
PREVENT FUEL WASTE FOR WAR
also PROTECT YOUR OWN INTERESTS

COMPLY NOW with the WPB and OPA Conversion Program and convert your SCOTCH TYPE BOILER to Coal Firing by installing the specially designed Leffel Underfeed Stoker, suitable only for the SCOTCH TYPE OF BOILER.

Note the long Retort distributing the heat evenly over the entire length of the firebox. Leffel Stokers highly approved by Insurance Companies.

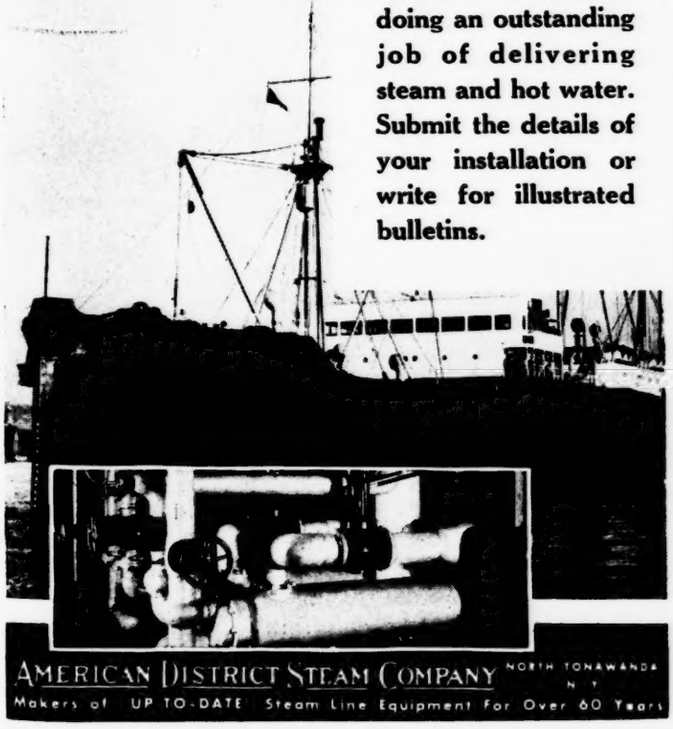
Leffel Stokers will increase the steaming capacity of the Boiler 150% of rating continuously and more for peak loads.

Bulletins Furnished on Request



THE JAMES LEFFEL & CO.
BOX HV *Established 1862* **SPRINGFIELD, OHIO**

ADSCO HEATERS *Sail the 7 seas*

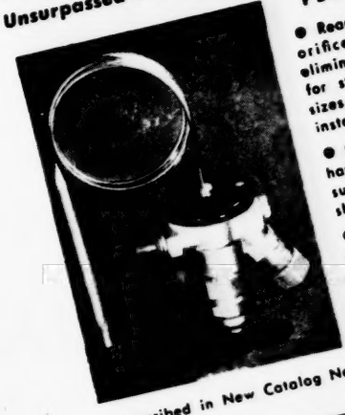


Not only in large defense plants and projects, but in big Merchant ships, ADSCO Heaters are doing an outstanding job of delivering steam and hot water. Submit the details of your installation or write for illustrated bulletins.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA N Y
Makers of UP TO-DATE Steam Line Equipment For Over 60 Years

V-200 THERMAL EXPANSION VALVE

Unsurpassed Sensitivity and Dependability

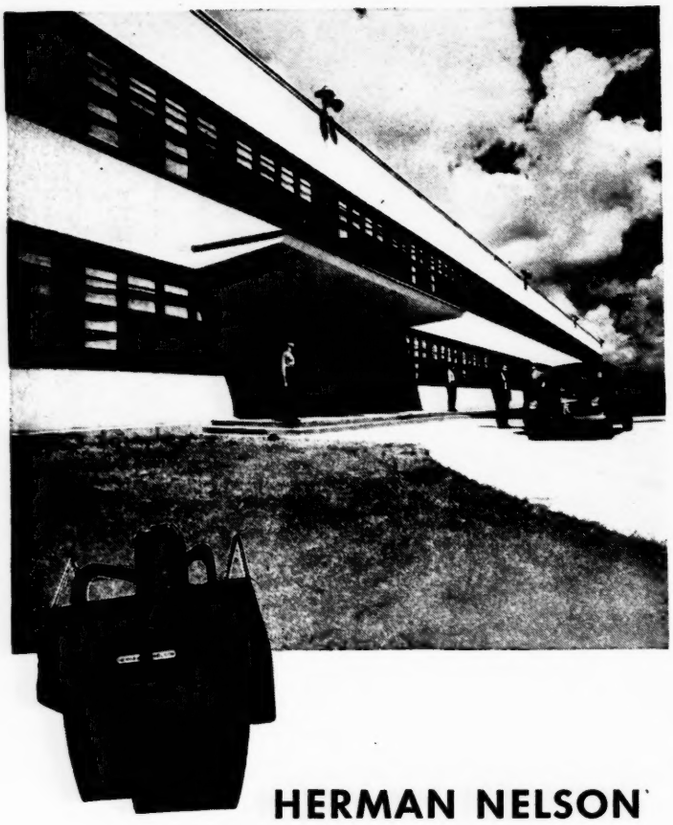


FEATURES

- Readily removed orifice cartridges eliminates necessity for stocking several sizes for low tonnage installations.
- Carefully lapped hard faced ball insures positive tight shut-off.
- Thoroughly field tested.
- Handles freon, methyl chloride, sulphur dioxide.

Described in New Catalog No. 52. Write today

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE, CALIFORNIA
Branches: Boston · New York · Detroit · Chicago · Dallas
Philadelphia · Cleveland · Denver · San Francisco



HERMAN NELSON
hiJet HEATERS installed at Douglas Aircraft Chicago Plant

Over 400 Herman Nelson Vertical Shaft Propeller-Fan Type hiJet Heaters are supplying comfortable temperatures in working areas at the mammoth new Chicago Plant of the Douglas Aircraft Company. Because Herman Nelson hiJet Heaters provide heat where it is wanted and when it is wanted, without waste of fuel or space, they are vitally important to the world's largest exclusive cargo-plane manufacturing plant.

In addition to many models, sizes and arrangements of hiJet Heaters, The Herman Nelson Corporation manufactures Autovent Fans and Blowers for industrial, commercial and public buildings. Thus practically any heating or ventilating problem can be most satisfactorily and economically solved with Herman Nelson equipment.

The Chicago Douglas Plant is scheduled to produce great numbers of these C-54 "Skymasters."

THE HERMAN NELSON CORPORATION
MOLINE, ILLINOIS
AUTOVENT FAN AND BLOWER DIVISION · CHICAGO, ILLINOIS
Manufacturers of Quality Heating, Ventilating and Air-Conditioning Products

(Continued from page 96)

DRAFT CONTROL

Preferred Utilities Co., Inc., 1860 Broadway, New York 23, N. Y.

A 16-page standard size bulletin that ties in closely with the fuel conservation program. Shows how, by installation of a simplified, automatic draft control device, it is possible to effect savings in fuel consumption of natural draft boilers. Features of the bulletin include a graph showing the relation between CO_2 and preventable fuel losses; a tabulation of essential requirements for a successful draft regulator and a table of ratings.

PUMPS

Joshua Henry Iron Works, Pomona Pump Co. Division, St. Louis, Mo.

A standard size, 60-page catalog 43, devoted to the line of Westco industrial pumps. Profusely illustrated and with capacity and dimensional information on the company's full line of non-self-priming, self-priming, heavy duty and special purpose industrial pumps.

WATER LEVEL INDICATOR

Yarnall-Waring Company, Philadelphia, Pa.

Bulletin WG 1820 covering the application and operating advantages of the Yarway remote water level indicator which brings boiler water levels to eye level reading on an illuminated, two-color scale mounting on the plant's instrument panel.

FUEL CONSERVATION

McDonnell & Miller, Wrigley Building, Chicago 11, Ill.

A 4-page, standard size mailing piece carrying a message under the imprint of the contractor or dealer and appealing to his customers to conserve fuel, and published in the interest of fuel conservation. Includes numerous hints to the home owner on how to conserve fuel. Available to contractors and dealers.

EXPANSION JOINTS

American District Steam Co., North Tonawanda, N. Y.

A 14-page, 8½ x 11 in. Bulletin 35-15C on the Adsco Piston-Ring-type slip expansion joint, which can be unpacked and repacked under full operating pressure; gives details of construction dimensions and list prices in sizes from 1½ in. to 20 in. for steam pressure to 400 lb.

AXIAL FLOW FANS

Hartzell Propeller Fan Co., Piqua, Ohio.

Catalog 14B, describing the company's complete line of axial flow propeller-type fans and blowers, and featuring the new duct fan, designed for quick and economical duct mounting, which was placed on the market in August. Unusually complete, the catalog pictures and factually describes each model of fan and blower, and gives standard test code air deliveries for every size in which fan is made. Of value to factory engineers concerned with ventilation and the cooling and drying of products are a number of pages devoted to formulae used in calculating air deliveries under various conditions. The catalog is carefully arranged and indexed for quick reference.

REFRIGERATION

York Corporation, York, Pa.

The second number of the company's publication "Cold Magic," handsomely printed, the first half of which is devoted to the application of refrigeration to war purposes, showing how the company's products are being used at sea, in the aircraft industries, manufacturing explosives, and so on. The second half of the publication consists of articles on stratosphere chambers, the high altitude tunnel at Wright Field, a description of the company's changed design of shell and tube evaporators, use of alternate materials in company's line of equipment, and one on packaged refrigeration and air conditioning.

METAL CHILLING

Deepfreeze, Div. of Motor Products Corp., North Chicago, Ill.

A 24-page illustrated Metal Chilling Data Book furnishing to the production man information and technical data on the application of Deepfreeze industrial chilling machines for the shrinking, testing, hardening and stabilization of metals. Many typical applications are described, showing the savings and increased production resulting from the use of Deepfreeze chilling equipment. For instance, one performance data story taken direct from the field shows how one manufacturer saved $3,000 to $4,000 per month over liquid air in the shrink-fit assembly of a bushing in the piston of a diesel engine. Another story shows how chilling in a Deepfreeze prevents expansion and growth of precision gages. Includes chart showing curve of transformation of Austenite to Martensite in high speed steel at temperatures varying from +400F to —120F; procedure commonly used in cold treatment of high-speed and moly-type steels; a method for calculating the rate of production obtained in reducing the temperature of a quantity of work to a specified temperature; method for determining the tolerances and dimensions required for handling shrink-fits; shrinkage table showing the approximate shrinkage obtained for various types of metals, and other pertinent data.

WITH THE MANUFACTURERS

WALLACE K. BROWN

former vice-president in charge of procurements for the Crocker-Wheeler Electric Mfg. Co., has been made manager of the New York district sales of the Crocker-Wheeler Division, Joshua Hendy Iron Works office. Mr. Brown first came with the Crocker-Wheeler Electric Mfg. Co. in 1908 as an apprentice engineer. Since that time he has been district manager in San Francisco and Newark and Eastern sales manager in New York.

J. W. COWAN

has been elected vice-president of Ad. Auriema, Inc., manufacturers' export managers. Prior to joining Ad. Auriema, Inc., in 1941, Mr. Cowan was with the International Division of Carrier Corp. Ad. Auriema, Inc., handles the export business of a number of manufacturers, including Spoehrer-Lange Company and White-Rodgers Electric Co.

(Continued on page 100)

WHITLOCK

HEAT TRANSFER EQUIPMENT

Serving America at Sea

Fuel Oil Heater for Marine use.

WHITLOCK Coolers and Heat Exchangers are made in many types for special applications afloat and ashore. Among WHITLOCK Products serving the marine industry are:

FEED WATER HEATERS
FUEL OIL HEATERS
LUBRICATING OIL COOLERS
JACKET WATER COOLERS
PREFABRICATED PIPING
COILS
REFRIGERANT CONDENSERS AND EVAPORATORS
COOLERS AND HEAT EXCHANGERS

WHITLOCK Engineers will gladly cooperate in the design of such equipment to meet the requirements of special problems. WHITLOCK's experience in the design and construction of such special units . . . in all the metals and alloys used in marine service . . . covers a wide range of applications and a period of many years. It assures a practical and efficient solution to your heating or cooling problems.

The WHITLOCK MANUFACTURING COMPANY

40 South St., Elmwood, Hartford 1, Conn.

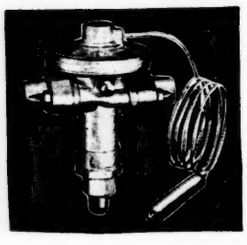
District Offices in NEW YORK, BOSTON, CHICAGO, PHILADELPHIA, DETROIT, RICHMOND

MEN
INDUSTRIES
NATIONS

Depend on REFRIGERATION accurately controlled...

One reason for America's superior might in weapons of war is Industry's new achievements in mechanical perfection... Working in accuracies of ten-thousandths and millionths of an inch—on a production-line basis. Such accuracies were so minute that parts could be assembled only after they were subjected to shrinking or contraction by specially built Refrigeration units under controlled temperatures . . . Another vital service of Refrigeration-at-war.

Here, as in all other phases of Refrigeration, the precision-control knowledge and experience developed at A-P is offering ready assistance, in more accurate and DEPENDABLE Refrigerant Control. Pacing new developments in the field, A-P Research Staff is already working with many manufacturers on post-war products that promise new and greater use for Refrigeration. This is a service YOU may be able to profitably use on your new plans!



AUTOMATIC PRODUCTS COMPANY
2462 N. Thirty-Second St.
Milwaukee 10, Wisconsin

DEPENDABLE
REFRIGERANT VALVES
STOCKED AND SOLD BY JOBBERS EVERYWHERE

(Continued from page 99)

ELMER H. CULVER

has been appointed director of sales by Henry Valve Co., Chicago. In his new capacity, Mr. Culver will supervise promotion and sales of the complete line of Henry valves, fittings, and accessories for the air conditioning and refrigeration fields, and will also direct the sales activities of the company's aviation division which concentrates on production of solenoid operated fuel and oil line valves. Mr. Culver has been associated with the air conditioning and refrigeration industries for twenty-five years, holding sales posts with Servel Inc., Westinghouse, and the Norge Division of Borg Warner. In the promotion of air conditioning products, he has had extensive experience with both York and Carrier distributing organizations.

Elmer H. Culver

THOMAS G. COLTER

formerly of Perkins & Colter Co., manufacturers' agents, has resigned his position with the War Production Board to become New England Air Valve representative of The Dole Valve Co. He will be located at 250 Stuart St., Boston 16, Mass.

ALFRED M. STREET

has been appointed publicity manager of Jenkins Bros., Bridgeport, Conn. In his new capacity he will direct the company's advertising, succeeding Charles C. Chamberlain, general sales manager. Mr. Street has been associated with Jenkins Bros. for the past twelve years. Prior to his new appointment he was assistant publicity manager.

WESTINGHOUSE ELECTRIC AND MFG. CO.

has announced the transfer of all heavy duty air conditioning and industrial refrigeration manufacture from its East Springfield, Mass., works to the Jersey City, N. J., plant of the Westinghouse Electric Elevator Company. According to George H. Bucher, president of the company, air conditioning will become a more important industry in post-war America and it is the intention of Westinghouse that it shall continue as one of the largest producers in the field.

Ross Rathbun

Ross Rathbun has been appointed as manager of air conditioning and Walker G. White has been appointed to succeed Mr. Rathbun as general sales manager of the Elevator Company. Mr. Rathbun joined Westinghouse in 1916 as sales engineer, joined the Westinghouse Electric Elevator Company in 1928, and in 1935 became general sales manager of the Elevator Company.

R. J. RUSSELL

vice-president and sales manager of the Century Electric Company, St. Louis, has been elected president of the Associated Industries of Missouri, an organization devoted to the promotion of fair business and employee relations policies among employers and employees in Missouri industries.

PREFERRED UTILITIES COMPANY

formerly of 33 W. 60th St., New York 23, N. Y., has moved its offices and storerooms to larger quarters at 1860 Broadway, New York 23, N. Y.

TUBE TURNS, INC.

Louisville, Ky., has opened two new West Coast offices. T. H. Pike, Jr., district manager for the Pacific Coast area, may now be reached at 2611-12 Russ Building, San Francisco. Since October 15 a second office has been maintained in Room 422-A, Smith Tower Building, Seattle 4, Wash. In this office John M. Hartley, formerly of the Los Angeles office, will handle matters pertaining to Washington, Oregon, and British Columbia.

JULES GRATIOT

has been appointed sales manager of The Air-Maze Corporation, Cleveland, Ohio. Mr. Gratiot was formerly district sales manager for Air-Maze on the West coast.

Jules Gratiot

ARMY – NAVY E AWARDS

Westinghouse Electric and Manufacturing Co. (Renewal of Award to nine plants)

The Fulton Sylphon Company, Knoxville, Tenn. (Addition of third star to Award)

Fitzgibbons Boiler Company, Inc., New York, N. Y.

Warren Webster & Company, Camden, N. J. (Addition of white star to Award)

Williams Oil-O-Matic Heating Corp., Bloomington, Ill. (Second award)

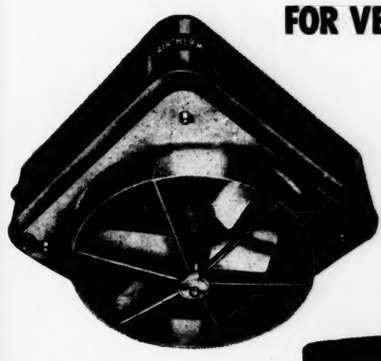
Schwitzer-Cummins Co., Indianapolis, Ind. (Addition of star to Award)

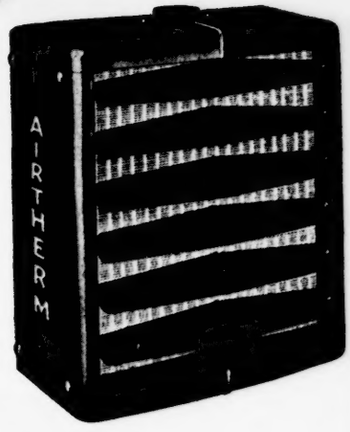
COMING EVENTS

DEC. 8-9 — 30th Annual Convention of the National Warm Air Heating and Air Conditioning Association to be held at the Netherlands Plaza Hotel, Cincinnati, Ohio.

JAN. 31—FEB. 2—50th Annual Meeting of the American Society of Heating and Ventilating Engineers to be held at the Hotel Pennsylvania, New York, N. Y.

FOR VERTICAL DELIVERY





FOR HORIZONTAL DELIVERY

AIRTHERM
UNIT HEATERS

NOW—MORE THAN EVER—
STURDY CONSTRUCTION COUNTS

To insure maximum heat and usage, all Airtherm Unit Heaters have these features:

Extra-heavy tube-wall thickness of .065".

Ingot iron tubes.

Lead-alloy coated condensers for greatest possible protection from corrosion.

Condensers guaranteed to withstand steam pressure up to 150 lbs. per sq. in.

AIRTHERM
MANUFACTURING COMPANY

722 S. SPRING AVE., ST. LOUIS, MO.